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ELECTROSTATIC AUGMENTATION OF FABRIC FILTRATION: REVERSE-AIR PILOT UNIT EXPERIENCE

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16. ABSTRACT The report describes the use of a pilot unit (consisting of two baghouses in a parallel-flow arrangement on a slipstream from an industrial pulverized-coal boiler house) to test electrostatically augmented fabric filtration (ESFF) in a reverse-air cleaning mode. ESFF is characterized by electrodes arranged about 2 cm apart around the circumference of the bag and running the length of the bag. An electric field of 2-4 kV/cm is maintained between the electrodes and perpendicular to the gas flow. Research results showed that ESFF can reduce fabric filter pressure drops and may allow reverse-air filtration at a 2 cm/s face velocity, rather than the conventional 1 cm/s. A filter bag with stainless steel electrodes woven into the fabric was developed for the reverse-air tests as part of this research. The woven-in electrode and the potential for doubling the face velocity appear to make ESFF economically attractive for commercial baghouse users.

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ABSTRACT

This report describes a test of electrostatically augmented fabric filtration (ESFF) on a pilot-scale reverse-air cleaned baghouse. The pilot unit consisted of two baghouses in a parallel flow path arrangement. A slipstream from an industrial pulverized coal boiler house was the ash source for the pilot unit. The baghouses could be operated in parallel, with one ESFF baghouse and one conventional unit. This mode of operation provided a direct comparison between conventional and ESFF operation with identical inlets. The baghouses could also be operated independently, with a different test program in each baghouse. Both operational modes, parallel and independent, were used during the test program. The fabric under test at all times was a 17-oz woven fiber glass fabric with a Teflon® B finish. A wide range of operating conditions was studied during the test program. The principal independent variables were baghouse face velocity and ESFF field strength. The main parameters monitored were particulate collection, baghouse pressure drop, and electrical power requirements.

Early in the program, it was recognized that successful operation of a large-scale ESFF baghouse required the development of a reliable and practical electrode system. During this project, a filter bag with stainless steel electrodes woven into the fabric was developed and tested in the pilot unit. Other candidate electrode designs were also developed and tested.

The results of this research show that reverse-air ESFF has the potential of reducing fabric-filter pressure drops and thus may allow increased operating face velocities. The flow resistance of the collected dust is substantially reduced by the presence of an electric field. A comparison of the average baghouse drag (pressure drop/face velocity) between the ESFF and conventional baghouses shows that the ESFF baghouse drag is about 70 percent of the conventional baghouse drag if ESFF is used on the bag for its full lifetime. This reduction in drag indicates that it should be

possible to operate the ESFF baghouse at a higher face velocity than is possible with a conventional baghouse. Such an operating mode makes ESFF economically superior to conventional technology.

The particulate control capabilities of the ESFF baghouse were about the same as for conventional filtration, the ESFF baghouse averaging 99.7 percent particle removal and the conventional baghouse 99.8 percent on a comparatively low inlet loading.

SECTION 1

INTRODUCTION

The use of fabric filters to remove particles from gas streams is a well-established industrial practice and its importance is growing for electrical utility boilers. The fabric filter is roughly equivalent in price to other utility control devices and provides increased particle removal efficiency. However, fabric filter operating experience is limited, and enough questions have been raised because of unexpectedly high baghouse pressure drops to cause concern in the industry.

A concept to improve fabric filtration through the use of electric fields (electrostatic stimulation of fabric filtration, or ESFF) was developed at laboratory scale by researchers at the Textile Research Institute (TRI), Princeton, NJ, whose work was partially supported by EPA. TRI showed that this concept could significantly improve filter performance by reducing filter drag and increasing filter efficiency. In work supported by EPA, the Research Triangle Institute (RTI), Research Triangle Park, NC, and ETS, Inc., Roanoke, VA, transferred the ESFF technology to the field environment by successfully operating a pulse-cleaned ESFF baghouse on a slipstream from an industrial boiler.

The results of this work were reported previously.[1] In brief, the pulse-jet pilot unit work was highly successful. The pulse-jet baghouse had a reduced residual pressure drop and a reduced specific dust cake resistance when compared to a conventional baghouse operated in parallel. In addition, the ESFF baghouse operated stably at higher face velocities than was possible with the conventional baghouse. Economic analysis indicated that an ESFF baghouse operated at 3 cm/s would have a 30-percent economic advantage when compared to a conventional baghouse at 2 cm/s, which is the approximate upper limit for conventional pulse-jet baghouses operating on coal-fired boilers.

In an effort to make the pilot unit results more relevant to the electric utility industry, the second phase of the pilot plant work dealt with reverse-air baghouses. The primary goal of the work presented in this report was operation of the ESFF technology on a reverse-air baghouse. This entailed electrode and bag development as well as pilot plant operation and testing. The pilot plant was converted to reverse-air operation and operated in that mode for about 18 months. This report discusses the reverse-air baghouse, the test work that was done, and the results. Section 4 discusses the background literature pertinent to ESFF, and includes a brief presentation of the forces involved in electrostatic augmentation. It also discusses the literature dealing with the TRI work, and provides a summary of the pulse-jet pilot unit work. Section 5 is a description of the ESFF pilot unit and standard operating procedures. The electrode development work accomplished during this program is discussed in Section 6. Pilot plant results are presented in Section 7, and Section 8 presents the results of an economic analysis of reverse-air ESFF.

SECTION 2

CONCLUSIONS

Electrostatic augmentation of fabric filtration utilizing an electric field parallel to the fabric surface (with no particle charging) has been applied successfully at pilot scale on a reverse-air baghouse.

The integral, woven-in electrode developed during this program is a reliable means of producing an electric field parallel to the fabric surface and has potential for commercial development.

At any given face velocity, the pilot ESFF baghouse had a reduced residual pressure drop and a reduced rate of pressure drop increase when compared to the pilot conventional baghouse.

Particulate mass emissions from the ESFF baghouse were not significantly different from conventional baghouse emissions.

Operation of a reverse-air ESFF baghouse at above conventional face velocities was not clearly demonstrated during this test program.

The average drag of both the conventional and ESFF baghouses increased as the face velocity was increased. The average drag decreased as the field strength was increased for all face velocities.

The current required by the ESFF baghouse did not depend on field strength or dust cake thickness within normal operating ranges.

An ESFF baghouse operating at 2 cm/s, using bags costing three times the cost of conventional bags, was estimated to have an annual cost 11 percent below a conventional baghouse at 1 cm/s. Bag cost and ESFF face velocity are the most important parameters in the economic comparison of ESFF with conventional operation.

SECTION 3

RECOMMENDATIONS

Reverse-air ESFF should be undertaken with relatively full-scale bags and with sufficient operating time to allow evaluation of long-term effects and benefits. Extended operation (a year or so) under field conditions is required to provide conclusive evidence concerning the design face velocity allowable for ESFF baghouses.

Work should be undertaken to improve the theoretical understanding of electrical effects in filters. Currently, generalizations from data are not possible. Variations in the inlet to the pilot unit made detailed study of many operational parameters difficult. Further laboratory-scale work, particularly at boiler temperatures, should be undertaken with considerable emphasis on model development based on the results.

The applicability of ESFF over a range of dusts and conditions should be evaluated through modeling and onsite testing in various environments.

SECTION 4

BACKGROUND

4.1 INTRODUCTION

The use of electrostatic phenomena to improve the performance of conventional fabric filters has only recently been tested in a commercial application, though the concept has been studied for some time. The previously reported study of pulse-jet ESFF and this present work on reverse-air ESFF are large scale in the field of ESFF. The forces acting to enhance filtration are the same in both the pilot unit and the laboratory, however, and previous research provides valuable insight into the ESFF phenomena. The forces that operate in ESFF and the approaches to electrical enhancement taken by other researchers were discussed in the report of pulse-jet ESFF work and will not be repeated here. The mechanisms that might account for the pressure drop reduction achieved with ESFF do merit comment, however, and Section 4.2 is a discussion of the potential mechanisms. Section 4.3 is a review of the TRI concept of ESFF, which forms the basis for the present work. The pulse-jet ESFF work is reviewed, and the results are summarized in Section 4.4.

4.2 MECHANISMS OF PRESSURE DROP REDUCTION

The ESFF effect can best be understood as the net effect of fundamental forces on particles--either charged or uncharged--in the presence of an electric field. While only one primary electric field is applied to the filter, that field interacts with the filter fibers and collected particles to form many localized gradients in the electric field. A particle approaching the filter is thus exposed to a complex field before it is collected. The electric field continues to have an effect on the particle after it is collected.

There are several changes in the pattern of dust deposition on a filter that might account for the reduced pressure drop effects observed with ESFF. These include:

1. An increased fraction of the collected dust being deposited on or near the upstream filter surface
2. Changes in the pattern of collection on a filter fiber, such as more dendritic collection and bridging
3. Formation of a highly nonuniform dust deposit--at the scale of the electrode spacing--on the filter surface.

An increased fraction of the dust being deposited near the upstream surface of the filter has been observed in laboratory studies of ESFF.[2] This observation is important because the upstream side of a fabric filter has a lower packing density than the body of the fabric. Collection in the less dense surface region, which is enhanced by the electric field, leads to reduced pressure drop for a given quantity of dust and reduces the amount of dust that penetrates the fabric. Reduced penetration into the depth of the fabric accounts for the reduced residual pressure drops observed.

Changes in the pattern of dust deposition on fibers have been observed by a number of researchers.[3] [4] [5] In general, the presence of an electric field leads to increased dendritic particle collection. The actual impact of dendritic deposition on filter drag is not clear. If the dendrites bridge between fibers and pack tightly, the resistance might be increased; if they remain in an open structure, the flow resistance should be reduced. Visual observation within a filter is difficult, and the effects of particle deposition on fibers remain uncertain.

If electrostatic forces cause the formation of a dust deposit with a nonuniform areal mass density, a reduction in pressure drop should result. This will be true, for instance, if coulombic forces cause most of the dust to collect in the immediate region of the electrodes, leaving reduced deposits on the balance of the filter.[6] Highly nonuniform deposits have been observed with redispersed fly ash in a laboratory ESFF filter apparatus.[7]

Stabilization of the deposited dust layer by the electric field has also been studied as a possible ESFF mechanism.[7] The theory has been developed in conjunction with fluidized beds and adhesion forces within electrostatic precipitator dust layers, but its application to the ESFF situation is fairly direct. It is postulated that the initial dust cake formation in an ESFF filter is quite porous due to the electrical gradient forces, and that the electric field prevents the collapse of this porous cake as the pressure drop across the filter increases. In ordinary filtration, this porous structure is assumed to collapse somewhat as the cake mass and pressure drop increases. The electrical stabilization preserves the initial high porosity, resulting in prolonged operation at lower drag than in the more compressible conventional operation.

4.3 TRI CONCEPT OF ELECTROSTATIC ENHANCEMENT

The use of electric fields perpendicular to the gas flow (parallel to the fabric) was pursued by TRI both on a 10-cm-diameter flat filter apparatus and on a small ambient-temperature bench-scale baghouse. The field was applied using a harness similar to that shown in Figure 1. The work at TRI led to the following general guidelines for ESFF system design.

1. The electric field should be parallel to the fabric surface. The field could be effectively produced by an array of relatively fine wires on the dirty-gas side of the fabric. The wires should be in contact with but not incorporated into the fabric.

2. The degree of electrostatic enhancement obtained is strongly influenced by the surface characteristics of the fabric. A low-density surface gives the best results.

3. The effect of the electrostatic augmentation is most obvious in reduced dust cake flow resistance and in reduced particle penetration.

To quantify the change in dust cake flow resistance, the pressure drop ratio (PDR) was defined as:

$$\mathrm{PDR} = \frac{(\Delta_f - \Delta P_r)_{ESFF}}{(\Delta P_f - \Delta P_r)_{control}} \qquad (1)$$

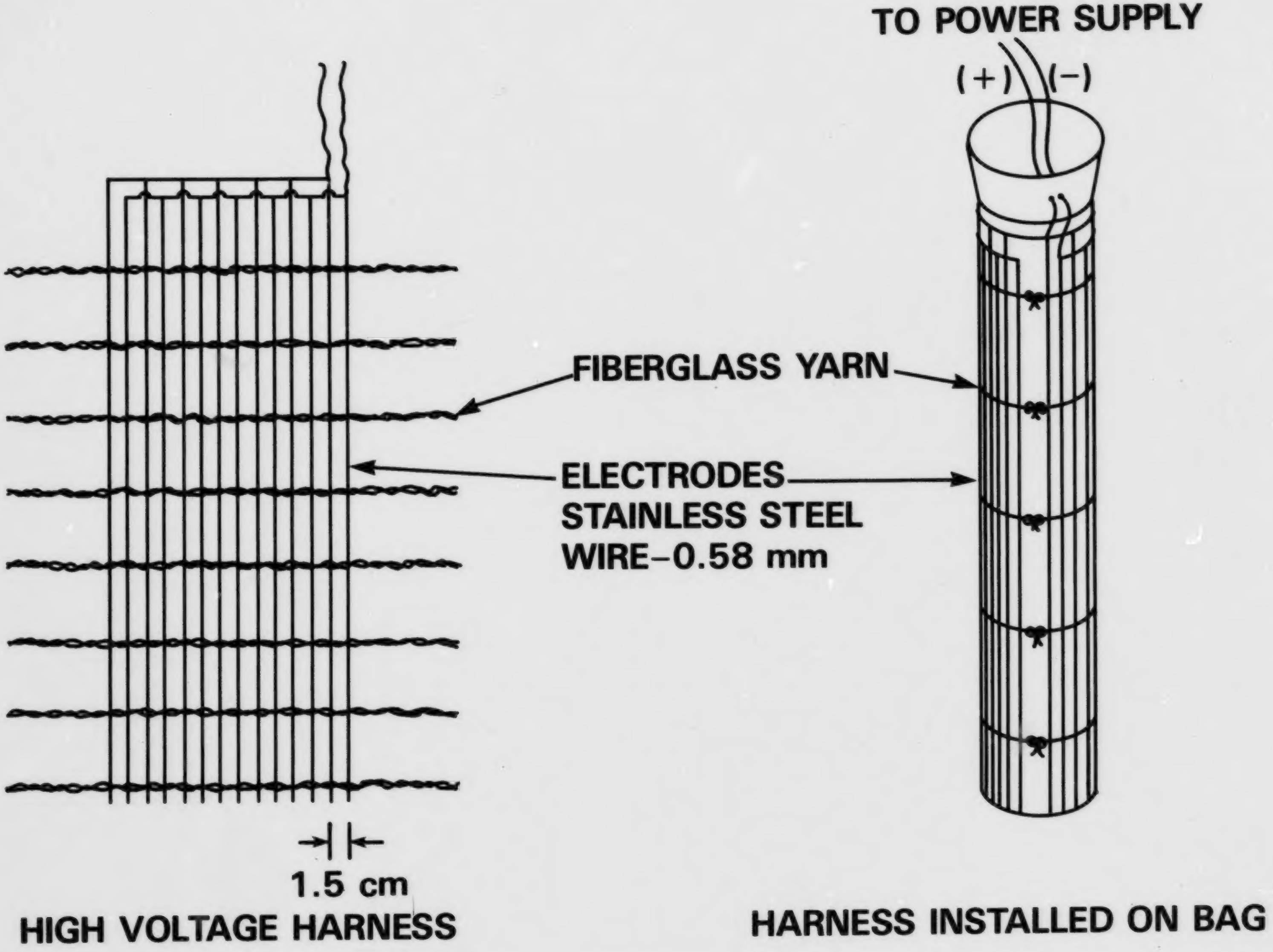

TO POWER SUPPLY
(+)
(−)
FIBERGLASS YARN
ELECTRODES
STAINLESS STEEL
WIRE–0.58 mm
1.5 cm
HIGH VOLTAGE HARNESS
HARNESS INSTALLED ON BAG

Figure 1. Harness for applying electric field parallel to the surface of a fabric filter bag.

where ΔP = the pressure drop across the bags,

f = the final state (just prior to cleaning),

r = the residual state (just after cleaning), and

control = a baghouse without electrical enhancement.

For an idealized filter cycle in which the bag pressure drop increases linearly with time at constant dust loading from ΔP_r to ΔP_f, it can be shown that:

$$PDR = \frac{(K_2)_{ESFF}}{(K_2)_{control}} \tag{2}$$

where K_2 = the specific cake resistance (drag per unit areal density).

PDR, then, is the ratio of the flow resistance of a dust cake collected by an ESFF system to that of a conventional fabric filter.

Results obtained by TRI using felted Teflon® fabric are presented in Figures 2a and 2b. These curves were obtained by averaging bench-scale unit data taken at four values of average electric field strength.

4.4 ESFF PULSE-JET PILOT UNIT EXPERIENCE

The TRI concept of electrostatically augmented fabric filtration was implemented at pilot scale on a slipstream from an industrial boiler. An ESFF pulse-jet and a conventional pulse-jet baghouse were operated in parallel on the slipstream. The results of this work were previously reported.[1] [9] [10] [11] In summary, the results were:

1. Dust Cake. Visually, the pulse-jet ESFF dust cake was identical to the conventional baghouse dust cake. Dust cake thickness, at least up to 2 or 3 mm, did not appear to affect the ESFF effect. The average bulk density of the dust collected in the ESFF baghouse hopper, at 0.23 g/cm^3, was only 80 percent of the average bulk density of the dust collected in the conventional baghouse.

2. Dust Cake Pressure Drop. The ESFF baghouse typically had a reduced rate of increase of pressure drop during a cleaning cycle (as compared to the conventional baghouse) and a reduced residual pressure drop. Figure 3 is a typical pressure drop plot for the pilot baghouses, and the reduced pressure drop of the ESFF baghouse is evident. Figure 4 shows pulse-jet pilot unit PDR results for

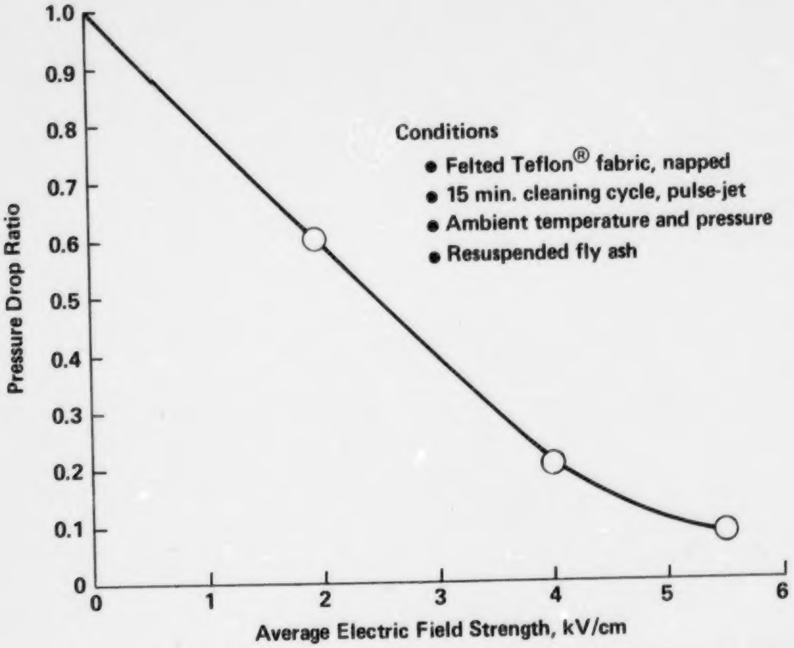


Figure 2a. Average PDR results from TRI bench-scale work (after Lamb and Costanza[8]).

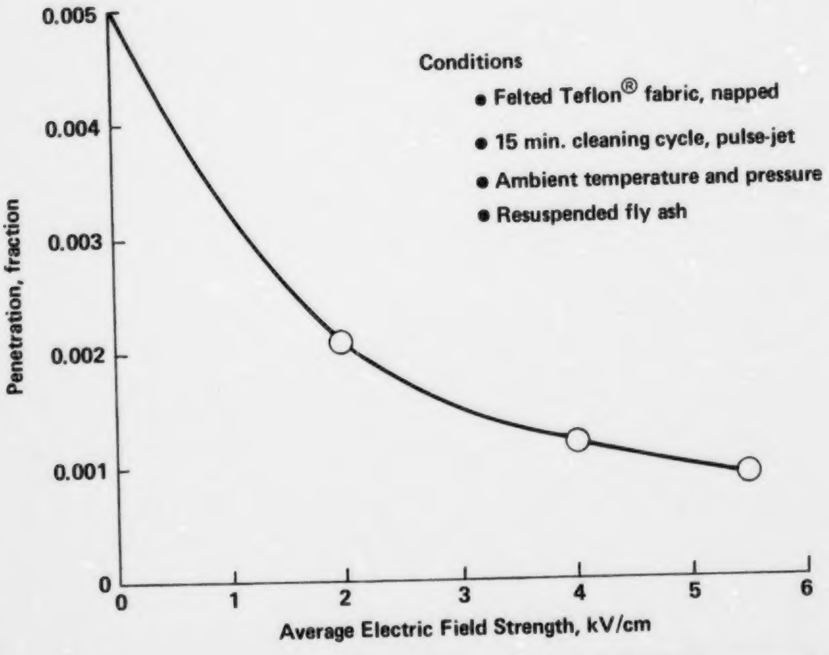
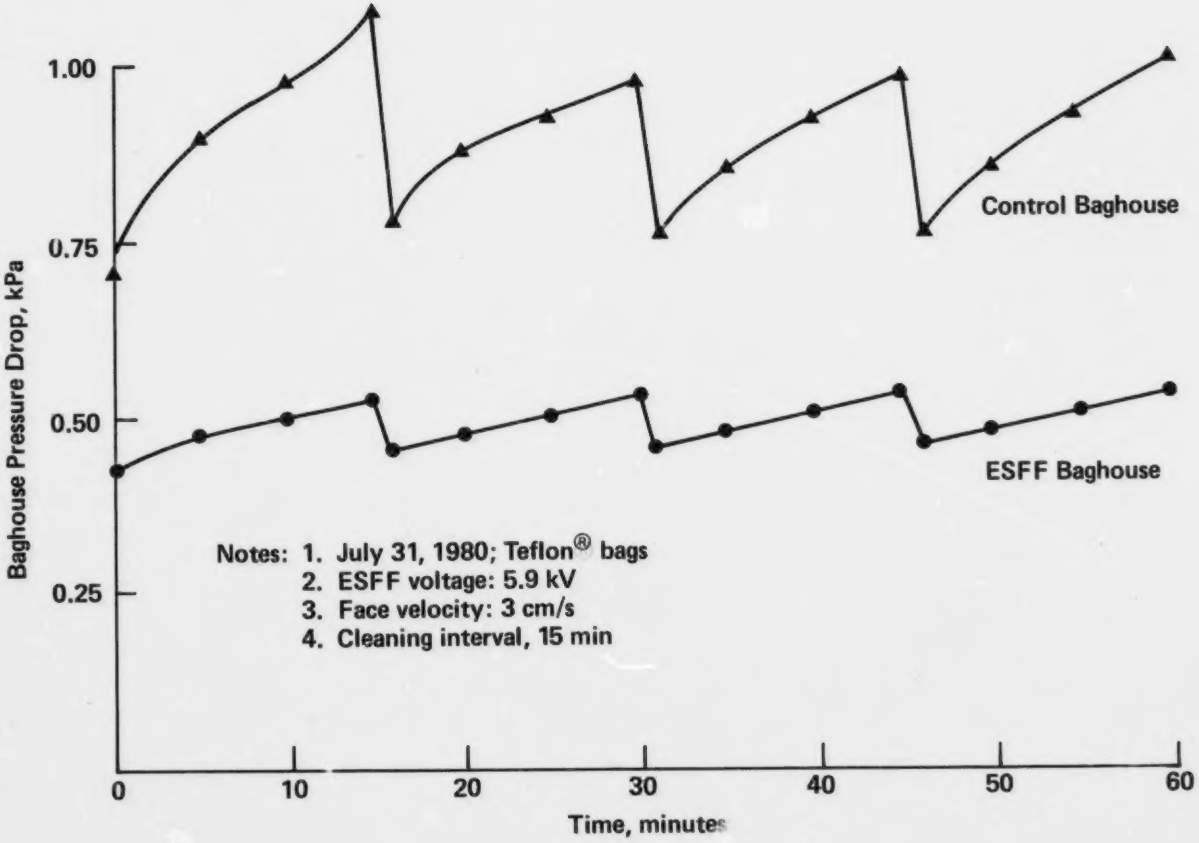


Figure 2b. Average penetration results from TRI bench-scale work (after Lamb and Costanza[8]).



Notes:
1. July 31, 1980; Teflon® bags
2. ESFF voltage: 5.9 kV
3. Face velocity: 3 cm/s
4. Cleaning interval, 15 min

Figure 3. Pressure drop plot for pilot pulse-jet baghouse.

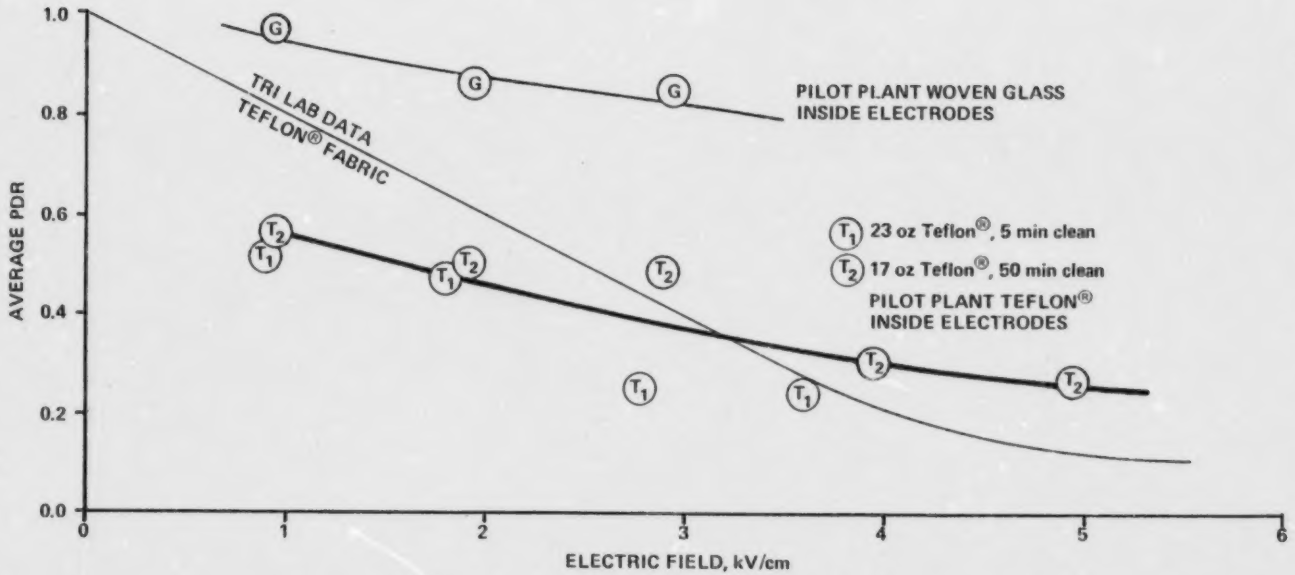


Figure 4. PDR-field strength relationship for felted Teflon® and woven fiberglass.

woven fiberglass and felted Teflon® fabrics. The Teflon® fabric results are similar to the results obtained by TRI, although less sensitive to field strength. PDR results were not affected by face velocity over the range (1.5 to 4.0 cm/s) studied at the pilot unit.

3. Reduced Residual Pressure Drop. ESFF had a significant effect on the residual pressure drop of the fabric. The average dimensionless reduction in residual pressure drop, expressed as:

$$R = \frac{\Delta P_{control} - \Delta P_{ESFF}}{\Delta P_{c}} \tag{3}$$

where ΔP = residual pressure drop, was 0.42 with a standard deviation of 0.27 for a 2-month operating period.

4. Operation at Increased Face Velocity. The pulse-jet ESFF baghouse was capable of operation at a higher face velocity without blinding than was the conventional baghouse. Figure 5 presents residual pressure drop results for both conventional and ESFF baghouses over several hours of operation at nominal face velocities of 2.5 and 4.0 cm/s. The superior performance of the ESFF baghouse is evident. Longer-term operation confirmed these results.

5. Particle Removal Efficiency. Particle removal efficiency for the ESFF and conventional baghouses was essentially the same, both ranging around 98 to 99 percent mass removal.

6. Electrical Requirements. Electrical power requirements for the pulse-jet ESFF baghouse were about 0.5 to 1.0 W/m^2 of fabric (0.05 to 0.1 W/ft^2).

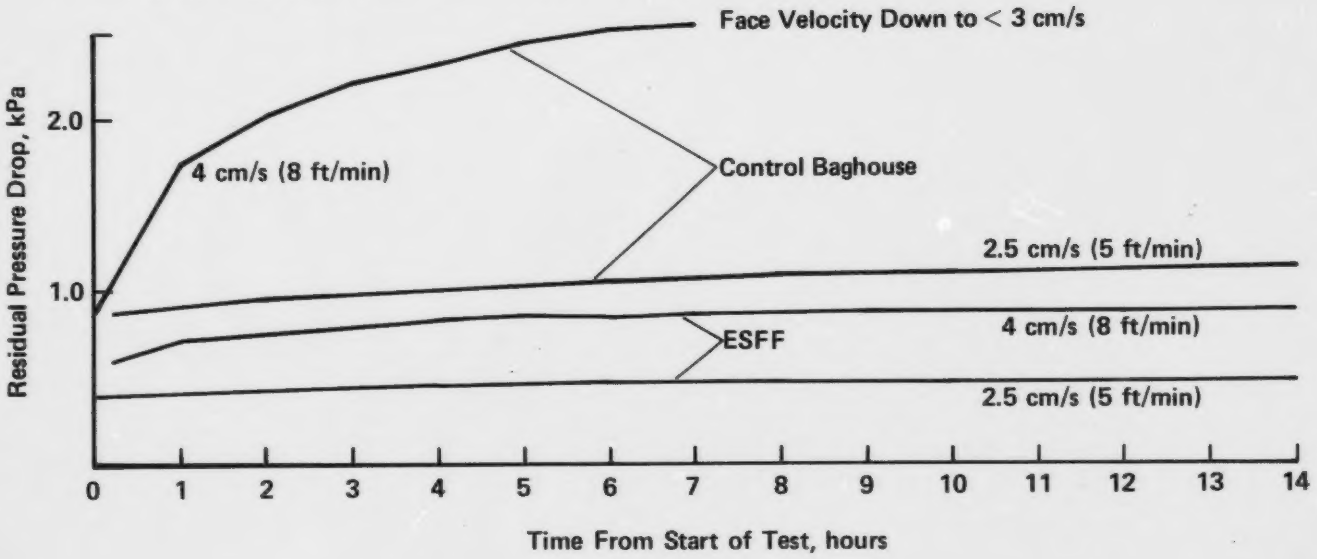

NOTE: Each Test Period Preceded by Multiple-Pulse Bag Cleaning

Figure 5. Residual pressure drop at two face velocities: pulse-jet pilot unit.

SECTION 5

ESFF PILOT UNIT DESCRIPTION AND OPERATING PROCEDURES

5.1 INTRODUCTION

The primary operating mode during the ESFF pilot unit test program was parallel operation of a conventional (control) baghouse and an electrostatically augmented (ESFF) baghouse. Boiler and coal variations in an operating boiler were expected to be too large for successful comparative testing to be done serially in time in a single baghouse. Testing was done serially (field on/field off) during portions of the test program only to allow different tests to be undertaken at the same time. The pilot unit could be operated as either a reverse-air or pulse-jet unit with relatively simple modifications. For most of the operating period described in this report, both baghouses were operated in the reverse-air mode. One baghouse was operated as a pulse-jet unit from August through December 1982. The following subsections describe the dust source, the pilot unit, and the electrical control system.

5.2 DUST SOURCE

The pilot unit was operated on a slipstream from the boiler house of the Waynesboro, VA, Du Pont fiber plant, which has been described by Marcotte.[12] Table 1 summarizes the boiler-house characteristics. The pilot unit slipstream was extracted from the baghouse breeching located above the pilot unit. A 6-in-ID (15.4-cm-ID) pipe nozzle was used to extract the slipstream, and a 15-m (50-ft) run of 6-in pipe brought the slipstream to the pilot unit flow splitter. From the flow splitter, 4-in-ID (10.2-cm-ID) ducts fed to both baghouses. At the pilot unit test ports, the inlet dust loading varied from 0.6 to 5 g/sm^3 (0.25 to 2 gr/scf). A typical value was about 0.7 g/sm^3 (0.3 gr/scf). In Figure 6, three pairs of simultaneous Method 5 mass concentration determinations are plotted to

TABLE 1. BOILER HOUSE DESCRIPTION

Number of boilers:	4
Type:	Pulverized coal with oil cofiring capability
Capacity:	68,200, 75,000, 75,000, and 70,000 kg/h of steam at 2,860 kPa
Operation:	Continuous
Normal load:	164,000 kg steam/h
Coal:	Highly variable
	Sulfur: 0.6 to 2.9 percent, average of about 1.3 percent.
	Ash: 6 to 27 percent, average of about 13 percent
Emission control device:	Reverse-air baghouse

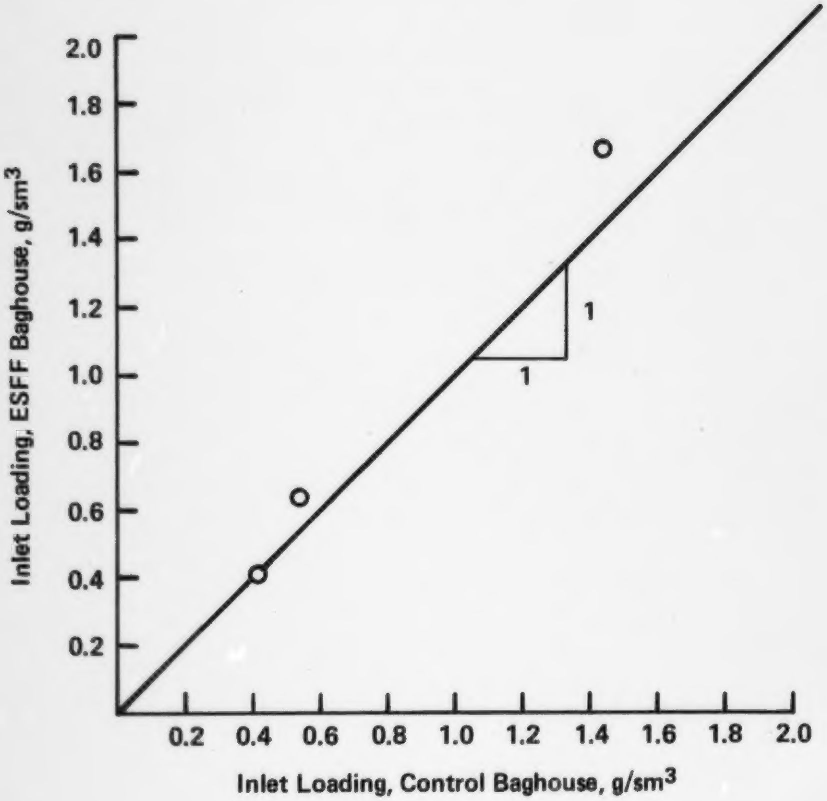


Figure 6. Inlet mass concentration comparison for ESFF and control baghouses.

compare the ESFF and control baghouse inlet loadings. The inlet loadings, while variable, were at any given time essentially the same for the two baghouses. These data were obtained during the pulse-jet test work; however, as the duct work was not altered, they remain valid for the reverse-air work.

5.3 PILOT BAGHOUSES AND TEST TRAILER

The ESFF pilot unit consisted of a test trailer, the baghouses, the cleaning system, and ductwork to bring the slipstream to the baghouses and return it to the breeching. The feed and discharge ducts for each baghouse were passed through the test trailer, and sample work was done within the trailer. A schematic of the pilot unit during normal operation is provided in Figure 7. All ductwork downstream of the inlet flow splitter was 4-in (10.2-cm) Schedule 40 steel pipe. The approximate locations of flow control and isolation valves are indicated in Figure 7. Testing was done through the indicated test ports, which consisted of slots in the duct wall, roughly 1 cm wide by 5 cm long. A 3-in (7.6-cm) female pipe coupling welded to the duct (and a pipe plug) provided a gas-tight seal for each port when not in use. The ductwork was insulated with 7.6 cm (3 in) of calcium silicate. The ports nearest the baghouses were used for all particle sampling.

Flow was measured by orifice plates on the inlet and outlet of each baghouse; a direct check of in-leakage was thus available. Pitot tubes, used through the sample ports, provided independent checks on the orifice flow rate indication. Flow control was by manual operation of the valve downstream of each baghouse. Blowers with a relatively flat operating curve were selected, and relatively small changes in baghouse flow occurred as baghouse pressure drop changed during an operating cycle. Flow through each baghouse was recorded using a transducer operating on the orifice downstream of the baghouse. Not shown on the schematic are the baghouse pressure drop taps, which were located just above and below the tubesheet of the baghouse for both reverse-air and pulse-jet operating modes. Each baghouse pressure drop was recorded continuously.

Figure 8 is an isometric drawing of the ESFF pilot unit baghouses. Table 2 outlines the features of the baghouses. The inlet ducting to the two baghouses was as identical as possible. The two baghouses were them-

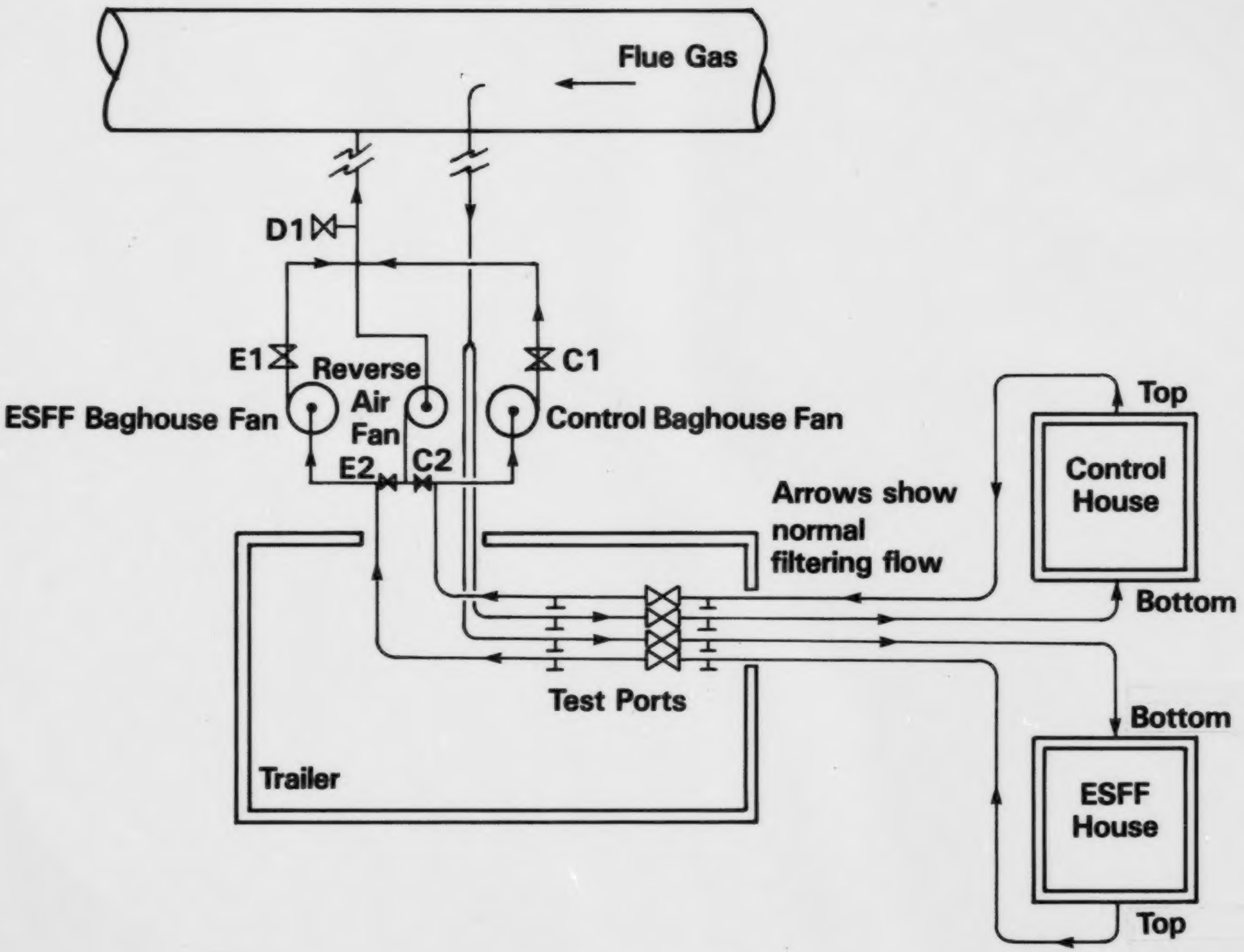

Flue Gas
D1
E1
C1
Reverse
Air
Fan
ESFF Baghouse Fan
Control Baghouse Fan
E2
C2
Arrows show
normal
filtering flow
Top
Control
House
Bottom
Test Ports
Bottom
ESFF
House
Top
Trailer

Figure 7. Schematic diagram of ESFF pilot unit.

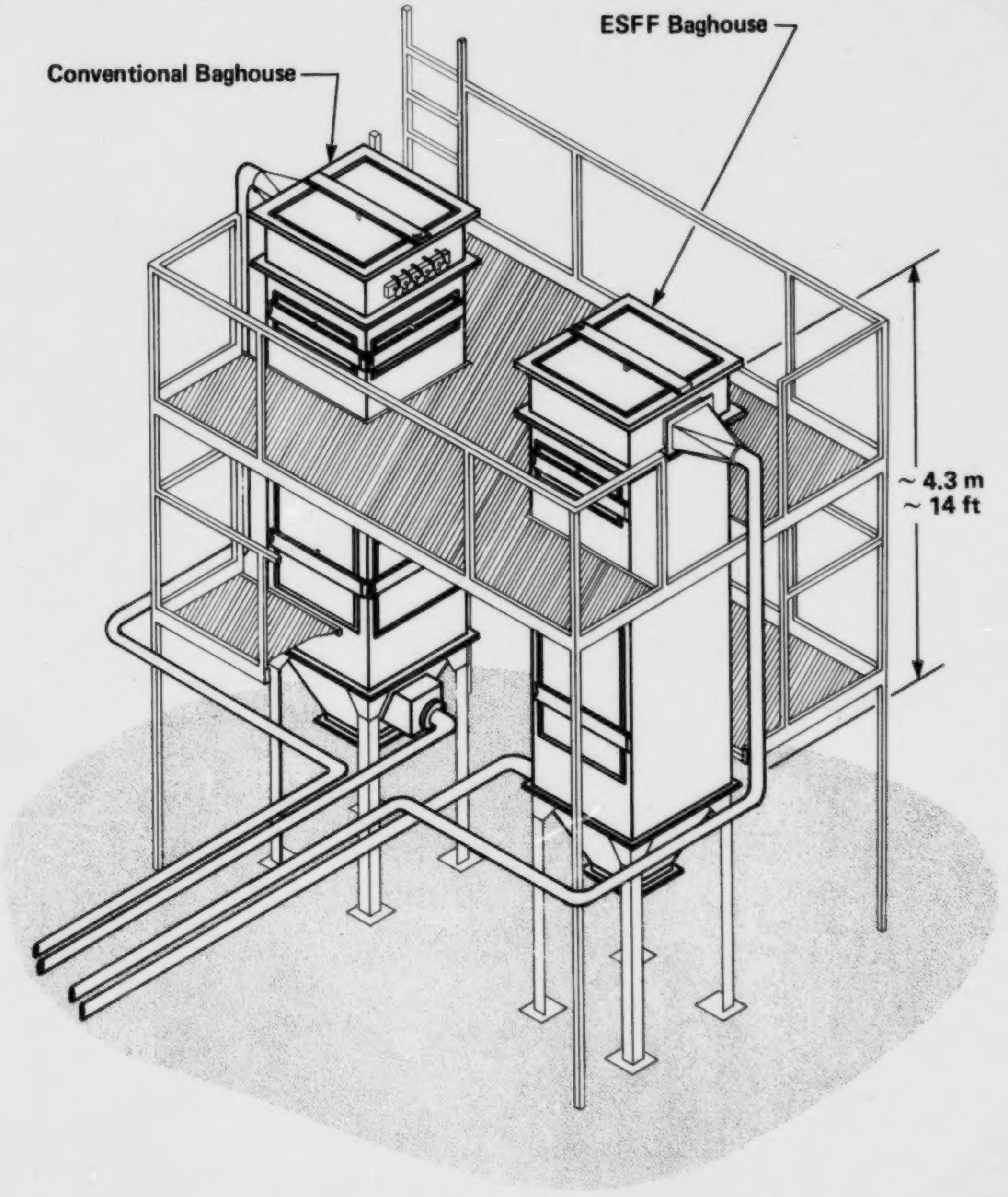

Conventional Baghouse
ESFF Baghouse
~ 4.3 m
~ 14 ft

Figure 8. Isometric drawing of pilot unit baghouses.

TABLE 2. PILOT UNIT FEATURES

Basic design:	Identical baghouses operating in parallel from boiler-house slipstream.
Baghouses:	Each 0.85 m (33 in) square by 4.3 m (14 ft) high. Designed for 2.8 to 14.2 m^3/min (100 to 500 cfm). Normal flow 5.7 to 8.5 m^3/min (200 to 300 cfm). In pulse-jet mode: 13-bag capacity, 3 rows of 3 bags alternated with 2 rows of 2 bags; spaced 20 cm (8 in) on centers. Normally operated with 3 to 5 bags. Bags were 11.4 cm (4.5 in) diameter by 244 cm (8 ft) long. Top loading of bags. In reverse-air mode: 9-bag capacity in 3 rows of 3 bags spaced 26.7 cm (10.5 in) on centers. Normally operated with 3 bags. Bags were 20.3 cm (8 in) diameter by 244 cm (8 ft) long. Insulation was 7.6 cm (3 in) calcium silicate on ducts, 7.6 cm (3 in) fiberglass on baghouses, and an additional 7.6 cm (3 in) fiberglass over doors. All insulation was covered with aluminum sheet. Access doors were located at 2 levels on 3 sides of the baghouses and at the top. Pulse-jet cleaning was by 50-ms pulse of 650 to 790 kPa (80-100 psia) air through blowpipe. Reverse air cleaning was at ~0.5 cm/s (1 ft/min). Both pressure drop and timed cleaning cycles were available.
Instrumentation:	Flow measurement by orifice plate ΔP at both inlet and outlet of each baghouse, and verified with pitot tube. Temperature measurement by thermometer at inlet and outlet of each baghouse. Baghouse pressure drop by pressure gauge and recorded via transducer.

selves identical when both were set up in the same operating mode (with the exception of the electrical hardware in the ESFF baghouse). During a normal cycle (either reverse-air or pulse-jet), dirty gas entered at the bottom of the baghouse, was filtered on the bags, and returned from the top of the baghouse.

In the pulse-jet mode, bags were installed in the pilot unit from the top, and cages were then inserted in the bags. The pulse-jet tubesheet was located about 30 cm (12 in) below the top of the baghouse. No venturis were used at the top of the bags. The cleaning pulses issued from 0.63-cm (0.25-in) holes in the bottom of blow pipes located directly above the bag openings. The pulse energy was kept constant for all bags. Cleaning was online during the test program. The cleaning pulse was of 50 ms duration from a 670-kPa (100-psig) header. Industry standard types of diaphragm pulse valves were used, controlled by standard pulse-jet controllers. Because of the anticipated use of the outside-harness ESFF electrode, the tubesheet holes were cut oversized at 14 cm (5.5 in) for the bags 11.4 cm (4.5 in) in diameter. The bag design was modified to include an enlarged cuff. The bags were sewn to be 11.4 cm (4.5 in) in diameter over most of their 2.4-m (8-ft) length. The top 20 cm (8 in) of each bag was expanded (through a concentric, truncated fabric cone) from 11.4 cm (4.5 in) to 14 cm (5.5 in) in diameter to fit the oversized tubesheet hole. Top insertion of the bag with harness electrode attached was possible. Center-to-center bag spacing was greater than that normally used on a conventional baghouse and was the same on both baghouses. The increased spacing was required for the first electrodes used at the pilot unit, but the new design developed during this project does not require additional spacing.

In the reverse-air mode, bag insertion was through a side door. The tubesheet was located between the hopper and lower door. The bags used with the cage electrodes were more or less standard except for length. The bag was placed inside the electrode cage, the entire assembly slipped into the baghouse, the tension spring attached, the bag clamped to the thimble, and the bag placed under tension. Each bag was tensioned to 178 N (40 lb). The later bag designs, with electrodes an integral part of the bag, were inserted in much the same way, except that no outside electrode cage was required.

The valving sequence used for the reverse-air baghouse is described below in the operating procedures section. Cleaning flow was normally about 0.5 cm/s (1 ft/min) and was applied in the order: clean one baghouse for 1 min, pause for 15 s, clean the other baghouse for 1 min, pause for 15 s, and repeat. Initially the cleaned gas leaving one baghouse was used as reverse air for the other, as indicated in Figure 7. This sequential cleaning was found to introduce bias into the experiment, thus in testing after January 1982, the baghouses were cleaned using outside air. As the air passed through the hot duct system, it was heated sufficiently to prevent moisture problems during cleaning. These changes in the cleaning protocols are described in more detail Section 5.5.

5.4 ELECTRICAL HARDWARE

The electrical hardware consisted of high voltage DC power supplies, current and voltage instrumentation, and the ESFF electrodes. The power supplies and instrumentation are shown schematically in Figure 9. Five identical power supply systems were provided for the ESFF baghouse. These provided flexibility in powering the ESFF electrodes and backup capability. It was often possible to power one bag from one power supply and therefore monitor bag current and voltage individually by bag.

The high voltage power supplies were mounted adjacent to the baghouse; instrumentation and control equipment was kept at relatively low voltage for safety and was located in the test trailer.

Electrode development was an ongoing process throughout this program. Four distinct reverse-air electrode designs were used at the pilot unit. The pulse-jet electrode used was largely developed during the first year's work, but was not field-tested until this program. Electrode development is discussed in some detail in the following section.

5.5 STANDARD OPERATING PROCEDURES

Normal operation of the baghouses was about the same for all test series. The baghouses were normally manned during the day-shift approximately every other day. Operating parameters for a test were set in the morning, observed for stability during the day, then checked and adjusted just before the operator left for the day. The desired face velocity for

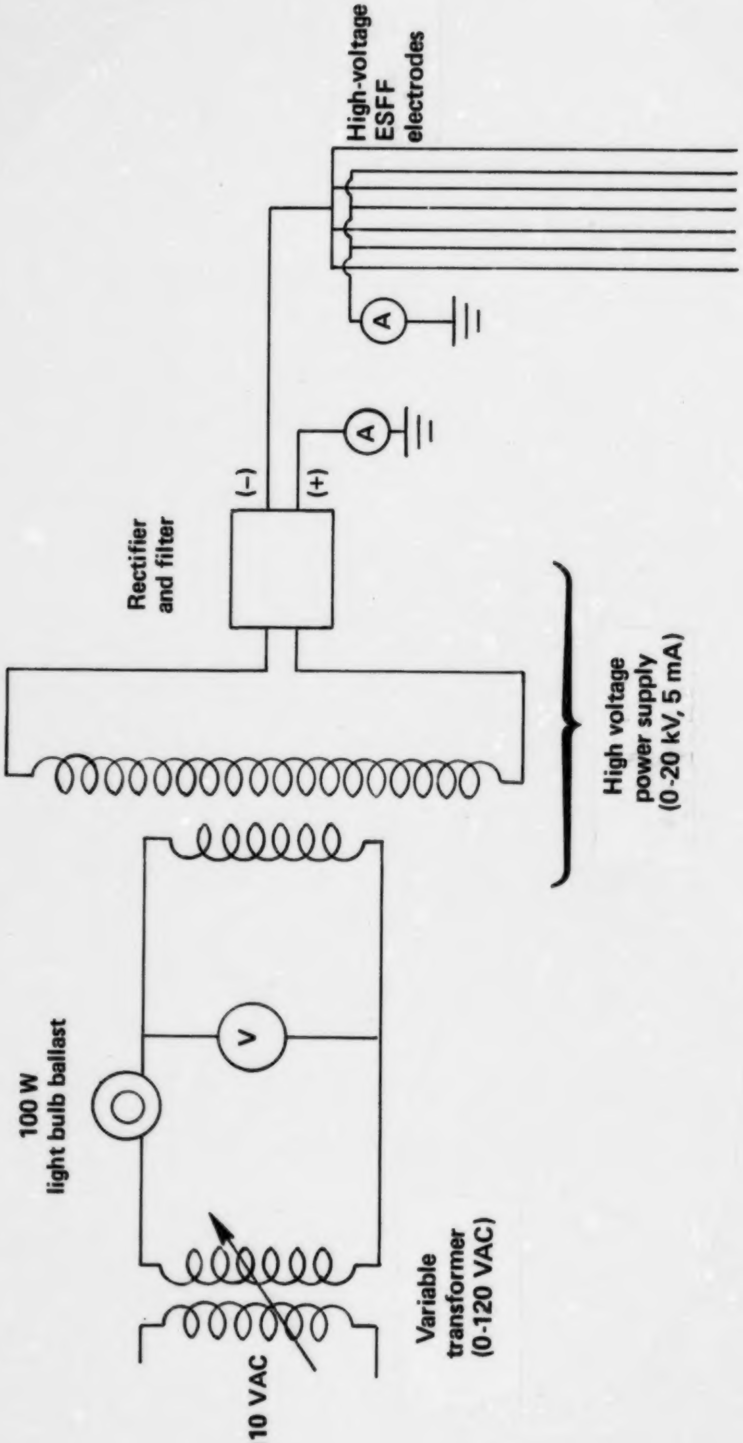

110 VAC
Variable transformer (0-120 VAC)
100 W light bulb ballast
V
High voltage power supply (0-20 kV, 5 mA)
Rectifier and filter
(–)
(+)
A
A
High-voltage ESFF electrodes

Figure 9. High voltage ESFF electrical circuit.

each baghouse was set using the outlet butterfly valve. The inlet valve was always fully open. Flow rate was determined both by the outlet orifice plate pressure drop and by checking with a pitot tube through the test ports. Normally flow was set by the pitot tube and monitored using the orifice. The face velocity was calculated based on the temperature within the baghouse hopper. The desired ESFF field strength was set by adjusting the variable transformer for the appropriate power supply to the proper AC output voltage. The output of the high voltage DC power supplies was linear with and had been calibrated against AC voltage on the primary, so it was not necessary to measure routinely on the high voltage side of the power supplies. Field strength was calculated as the high voltage DC potential divided by the inside-edge-to-inside-edge spacing of the electrodes.

For both reverse-air and pulse-jet operation, cleaning could be controlled with a timer or by pressure drop. Normally the cleaning cycles were timed, but the break-in of new bags was usually on pressure drop control. In reverse-air operation, two distinctly different cleaning modes were used during the test work. Initially, the two pilot baghouses were set up to clean sequentially; the cleaned gas leaving the online baghouse being was used as reverse air in the other baghouse. Thus, the outlet damper from one baghouse was closed, taking it offline; the exit gas from the other was routed to the top of the baghouse being cleaned; the baghouse was cleaned; and the reverse air then drawn through the reverse-air fan and discharged back to the power plant breeching. The same technique was then used to clean the other baghouse. Referring to Figure 7, the sequence used to clean the baghouses was: (1) turn on the reverse-air fan and enter 15-s null period; (2) close valve E1, open valve E2, and clean the ESFF baghouse; (3) open valve E1, close valve E2, and enter 15-s null; (4) close valve C1, open valve C2, and clean the control baghouse; (5) open valve C1, close valve C2, and enter 15-s null; (6-9) repeat steps 2-5; (10) turn off the reverse-air fan and return baghouse to normal operation. The bags were cleaned twice because laboratory data indicated that ESFF was most advantageous with well-cleaned bags. The control baghouse was cleaned last to give it any advantage in the comparison. However, after some operating experience, it was found that the cleaning order was actually a slight advantage for the ESFF baghouse. After this difficulty with the sequential cleaning technique was discovered, the reverse-air baghouses were cleaned using outside air as the cleaning medium, with no recycle of dust from one baghouse to the other, by keeping valves C1 and E1 closed and valve D1 opened during the cleaning cycle. The thermal capacitance and heat transfer characteristics of the inlet duct were such that the reverse air was adequately heated when it was drawn in at the outside-air damper located just upstream of the inlet wye. Except for the source of reverse air, the cleaning sequence was the same for both cleaning methods.

When in the pulse-jet operating mode, the baghouse was cleaned on-line, usually on a 15-min timed cycle. The pulse duration was 50 ms, and the reservoir pressure was about 670 kPa (100 psig).

SECTION 6

ELECTRODE DEVELOPMENT

6.1 INTRODUCTION

The TRI concept of ESFF requires that an electric field be created at the surface of the fabric filter. As described earlier, this was first accomplished by attaching an electrode harness to the outside of the bag. The harness was awkward to use, and it led to an early realization that the convenience and reliability of the electrode system was essential to the eventual acceptance of ESFF as a useful technology. For this reason, one of the program goals was to develop ESFF electrodes, and considerable effort was expended during the program to improve the electrode system. Two categories of electrodes were considered: (1) electrodes that are separate from the filter fabric and must be mounted in proximity to the filter to function, and (2) electrodes that are integral to the filter fabric. Development efforts in both directions are described in this section.

6.2 ELECTRODES MOUNTED NEAR FABRIC

The initial electrode design developed by TRI for pulse-jet use was constructed of thin wires glued to insulating yarns to form an electrical harness. The harness was tied to the outside of a pulse-jet bag. It was necessary to coat the cage inside the bag with a nonconductive material to prevent the harness from shorting-out. This design was chosen because it was fairly simple to construct, and laboratory test results indicated that the ESFF effect was much stronger with the electrodes on the dirty, dust-laden side of the fabric. As was related in the report on pulse-jet pilot unit experience,[1] electrodes of the TRI harness type were initially installed at the ESFF pilot unit and were used during most of the pulse-jet test program. The materials used to construct the harnesses and insulate the cages were not reliable at the elevated temperatures and flue gas atmosphere, however. In addition, tying the harness to the outside of the bag restricted bag motion and reduced cleaning efficiency.

The practical shortcomings of the harness design led to an attempt to use electrodes placed on the clean side (inside) of the bag. A special pulse-jet cage was constructed in which alternate cage rods were electrically connected but were electically isolated from all nearest neighbor rods. The electric field was thus formed between the long vertical rods of the cage. With this cage/electrode combination, it was not necessary to have the electrodes on the dirty side of the fabric. In fact, performance was equally good on either side of the fabric. This electrode design was well suited to a pulse-jet baghouse, because a cage was needed to support the bag even in conventional operation. The cage/electrode was not very different from conventional cages and was estimated to be only slightly more expensive. The only additional items needed to convert to ESFF operation were the power supply and electrical distribution system. Economic projections based on the performance of the pulse-jet ESFF and estimated hardware costs were very favorable.

The conversion of the pilot unit from pulse-jet to reverse-air cleaning required a different approach to electrode design. The reverse-air baghouse had the dirty gas on the inside of the bag rather than the outside. Collapse of the bag during cleaning could not be hindered, or cleaning would suffer drastically. The cage-type electrode was not a desirable choice. A cage 9.5 m (30 ft) tall by 30 cm (1 ft) diameter would be unwieldy and probably impossible to install in baghouses of conventional design. It would certainly be heavy and expensive. For these reasons, the conversion from pulse-jet to reverse-air operation was accompanied by the start of a program to develop an electrode system integral to a reverse-air bag. This program is described later in this section.

While this electrode development program was in progress, cage-type electrode systems were used at the pilot plant. Previous pulse-jet experience suggested that ESFF performance data were not dependent on electrode type. Essentially identical results had been obtained with the TRI harness, consisting of 0.58-mm (.023-in) wires tied to the dirty side of a bag, and with 3.18 mm (0.125-in) wires on the clean side of the fabric. Thus it was expected that reverse-air ESFF data obtained using one electrode type would be similar to that obtained with another electrode type.

The first electrode cage used with the reverse-air unit was essentially the same as a design developed for, but never tested with, pulse-jet ESFF. A drawing of this rigid cage is presented in Figure 10. The cages used at the pilot unit were constructed by a commercial wireforming company using equipment on which pulse-jet cages are made. Some modifications and hand work were necessary, but construction was within the scope of conventional equipment. The horizontal rings were polygons rather than circles, and thus presented a flat surface to the insulators. The small ceramic insulators were grooved front and back, with the grooves running at right angles to each other. The insulators were inserted into the cage by hand.

The rigid cage served adequately at the pilot unit. Because the bags were only 2.44 m (8 ft) long by 20.3 cm (8 in) in diameter and were spaced 26.7 cm (10.5 in) on centers, there was adequate space to insert and use the cages. Its only limitation was that the ceramic insulators were limited to about 9 kV before shorting through, and field strength was limited to just over 3 kV/cm.

A second type of cage was designed to overcome this difficulty. In addition, this new cage was flexible and easier to install. Figure 11 is a drawing of the "flexible cage." The horizontal, woven, fiberglass tapes were sewn with pockets through which the electrode wires were inserted. This electrode design could be operated up to about 5 kV/cm before arcing along the surface of the tape occurred.

6.3 ELECTRODES INTEGRAL TO THE FABRIC

The development of electrodes integral to the bag fabric was pursued in three directions more or less concurrently. These were the development of: (1) printed ESFF electrodes, (2) sewn-on ESFF electrodes, and (3) ESFF electrodes woven into filter fabric.

The concept of printing electrodes on filter fabric has many advantages. No changes would be required in the filter fabric, and thus industry experience with bag life, penetration, and general suitability of a fabric for a specific application would be applicable. Experimentally, printed electrodes would be easy to work with and could be used with different fabrics and bag

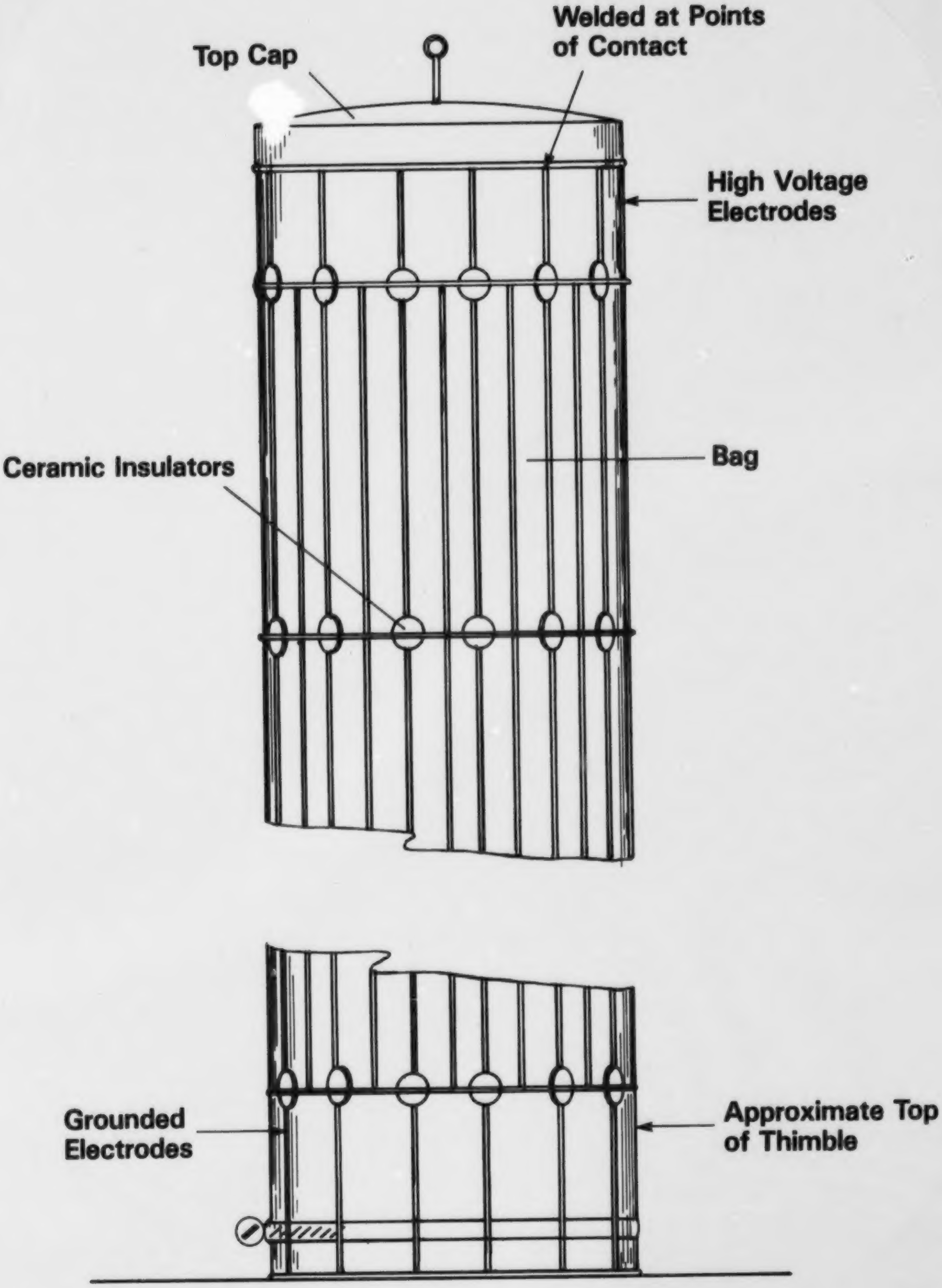

Top Cap
Welded at Points of Contact
High Voltage Electrodes
Ceramic Insulators
Bag
Grounded Electrodes
Approximate Top of Thimble

Figure 10. Reverse-air "RIGID" cage.

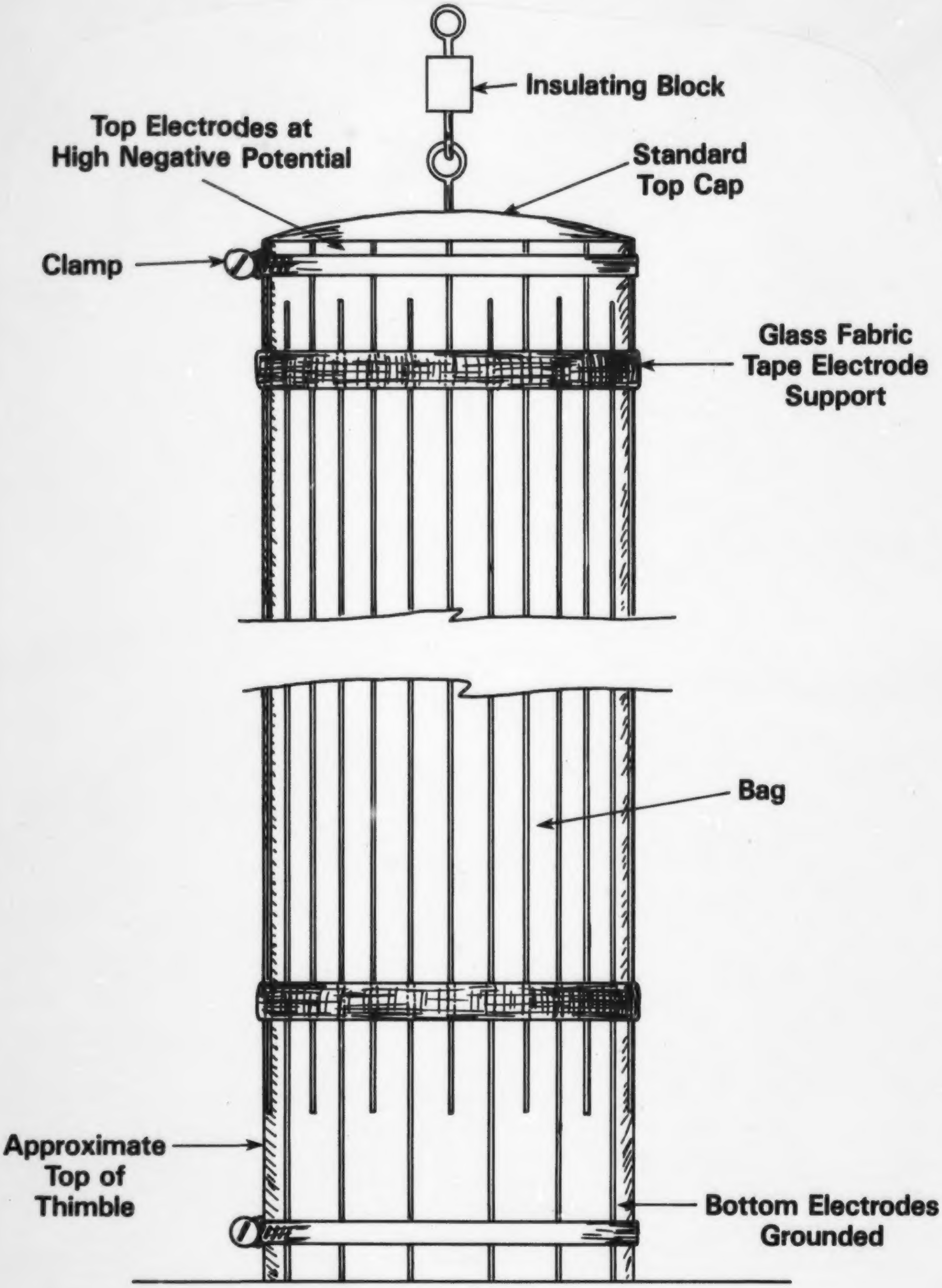

Insulating Block
Top Electrodes at High Negative Potential
Standard Top Cap
Clamp
Glass Fabric Tape Electrode Support
Bag
Approximate Top of Thimble
Bottom Electrodes Grounded

Figure 11. Reverse-air "FLEXIBLE" cage.

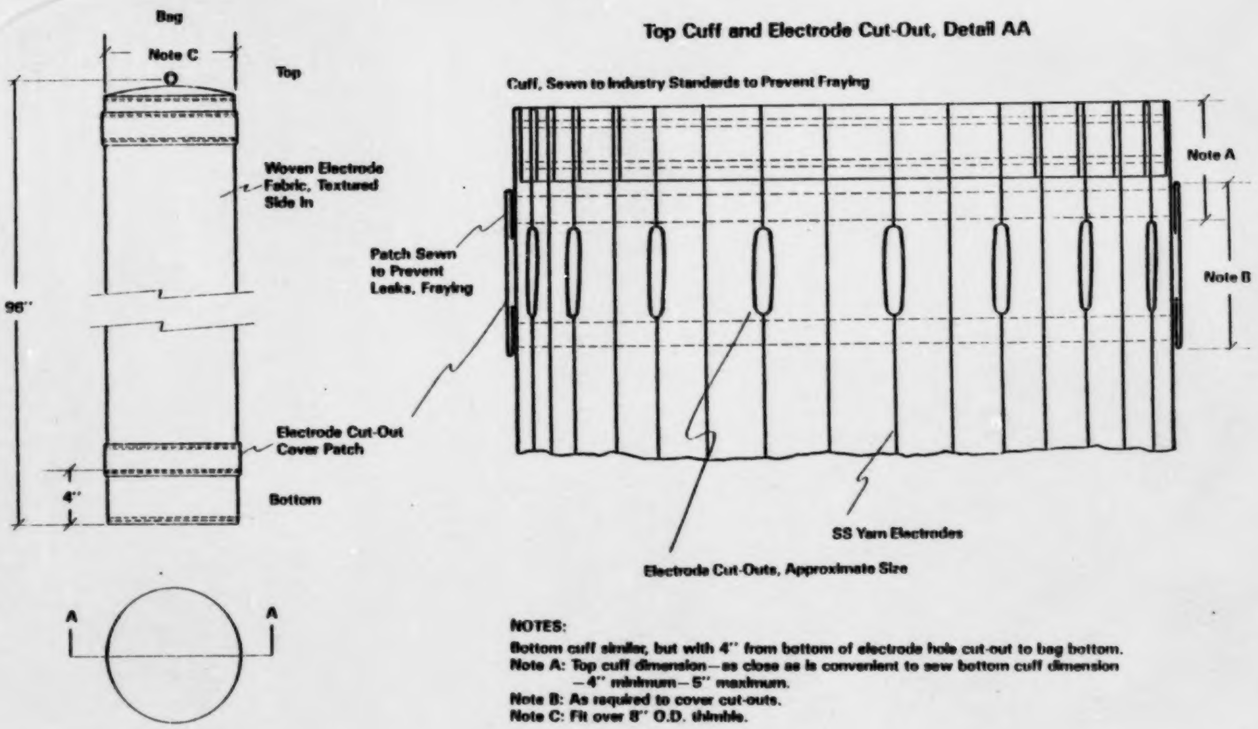
styles. A type of printed electrode filter bag is already in use in the United States for low temperature, antistatic applications.

The concept of using printed electrodes in the ESFF application was pursued by TRI. Printed electrodes were found to give a suitable ESFF effect when applied to a polyester felt. However, the formulation used was not suitable for high temperature flue gas service, so research to identify suitable materials was undertaken. However, no suitable compounds were identified and active research on the concept was stopped until a suitable material should become available.

The concept of sewn-on electrodes was studied and actually put to use at the pilot unit. TRI had sewn small wires to existing bags during the early phases of the laboratory test program. The advantage of the sewn-on electrodes was that the wires could be a material resistant to the baghouse environment. The major anticipated disadvantages were the large amount of hand labor required to make the bags and the number of pinholes made by the stitching. In several sewn-on electrode bags constructed, the electrodes spiraled down the bag in a double helix arrangement. Connection to one polarity was made at the bottom of the bag and connection to the other through the top cap. These bags were found to give a satisfactory ESFF effect, but to have above-average particle penetration. This concept appeared to be inferior to the woven-in electrode fabric concept, and development was halted.

The use of electrodes woven into the fabric was the object of considerable study. A test run was first made with three types of electrode material--a stainless steel fiber yarn, a carbon yarn, and a stainless steel-nylon blend. The initial attempt was to produce a heavy-weight woven glass fabric with the electrode yarn woven in the fill direction. The weaver was able to make fabric from all the materials, and laboratory tests showed that the woven electrode fabric had a satisfactory ESFF effect. Despite being the most difficult to weave of the yarns attempted, the stainless steel yarn became the electrode of choice because of its durability. The carbon yarn was far too fragile for this application, and the nylon in the nylon-steel blend was not suitable for the temperatures in the pilot baghouse.

A textile company willing to weave a trial run of woven electrode fabric was found, and sufficient fabric for pilot plant use was made. The electrodes were stainless steel yarns, each yarn containing 90 filaments, each filament 22 μm in diameter. The steel yarns were woven in the warp direction, at 2-cm spacing. Bags were constructed from the woven electrode fabric by cutting out a short segment of every other electrode at the top of the bag and a short segment of the alternate electrodes at the bottom of the bag. This resulted in a bag with one set of electrodes continuous through the bottom cuff but electrically isolated from the top cuff, and another set of parallel, alternate electrodes continuous through the top cuff but isolated from the bottom. The top cap was then used as a bus to connect all the high voltage electrodes together; the thimble and bottom clamp served as the ground bus. Figure 12 is a drawing of a woven electrode bag as constructed for the pilot unit. The performance of the woven electrode bag at the pilot unit was essentially the same as that of other varieties of reverse-air electrodes.


Bag
Note C
Top
96"
Woven Electrode Fabric, Textured Side In
Electrode Cut-Out Cover Patch
4"
Bottom
A
A
Top Cuff and Electrode Cut-Out, Detail AA
Cuff, Sewn to Industry Standards to Prevent Fraying
Patch Sewn to Prevent Leaks, Fraying
Note A
Note B
SS Yarn Electrodes
Electrode Cut-Outs, Approximate Size

NOTES:
Bottom cuff similar, but with 4" from bottom of electrode hole cut-out to bag bottom.
Note A: Top cuff dimension—as close as is convenient to sew bottom cuff dimension —4" minimum—5" maximum.
Note B: As required to cover cut-outs.
Note C: Fit over 8" O.D. thimble.

Figure 12. Woven-in electrode bag.

SECTION 7

RESULTS

7.1 INTRODUCTION

The primary measure of the ESFF effect is the reduction of pressure drop at various baghouse operating conditions. Both the residual pressure drop and the final pressure drop of the ESFF bags were reduced in comparison with conventional technology. In the following subsections, ESFF and conventional technology are compared on the basis of average drag. Because average drag was a function of time for the relatively short test periods used at the pilot unit, comparisons were made after a bag break-in period and with bags of about the same age. Section 7.2 presents three comparisons of conventional and ESFF baghouse drags. The electrical power requirements of the ESFF system are presented in Section 7.3. Sections 7.4 and 7.5 deal with the properties of the dust cake on the filter and the properties of the fly ash. Particle size and mass loading are the subject of Section 7.6, and Section 7.7 discusses the particle removal capabilities of the pilot ESFF baghouse.

7.2 BAGHOUSE DRAG COMPARISONS

7.2.1 Long-Term Test Periods

For much of the ESFF test program, baghouse parameters were deliberately varied so that relatively long-term performance at a fixed face velocity could not be evaluated. This is not a departure from normal baghouse operation as baghouse load swings are commonplace occurrences. The ESFF baghouse average drags from May through August 1982 are presented in Figure 13. These data show a fairly steady increase in average drag over the first 2 months of operation, followed by a period with no overall changes but large variation about the apparent mean. Based on these results, data analysis in the following sections has been limited to data collected at

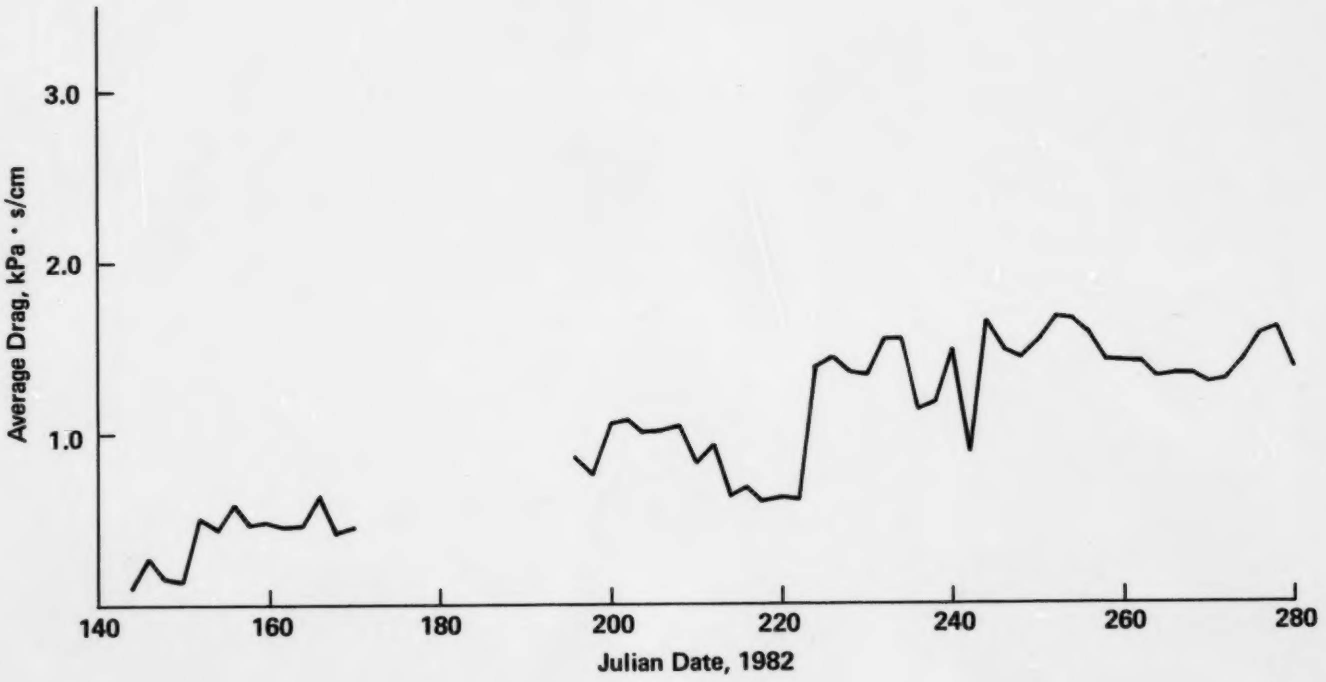


Figure 13. Long-term drag of ESFF baghouse.

about the same time from bags of about the same age and history. The baghouse without ESFF had a similar drag history, although the value was higher.

7.2.2 Drag Comparisons Over Similar Operating Periods

The data presented in Tables 3 and 4 were selected from the overall data pool to provide the clearest available contrasts between ESFF and conventional baghouse operation. Table 3 presents comparisons between the average drag in the ESFF baghouse and that in the conventional baghouse for the two baghouses operating in parallel. The bags in both baghouses were constructed of the same material and were of the same age. Each data pair compares bags with about 1 month of use, and each is an average over 3 or more days' operation. The data in Table 3 show that the average drag for a baghouse operated as an ESFF baghouse continuously could be expected to be 65 to 70 percent of the drag in a conventional baghouse.

The data in Table 4 are much like those in Table 3. The bags are about 1-month old and of the same fabric. In this case, however, the comparisons are between periods of field-on and field-off operation in the same baghouse. That is, the bags were operated with an ESFF field for a period of time and then the field was turned off for a period of several days. In some cases the field was then turned on again. The ratio of drags averages about 0.9 compared to the ratio of 0.65 to 0.70 found for the data in Table 3.

This comparison of Tables 3 and 4 indicates that applying the ESFF field continuously is decidely more advantageous than turning the field on and off.

7.2.3 Effect of Field Strength and Face Velocity on Drag

The effects of electric field strength and face velocity on drag were investigated during three test periods. Data from these tests have been consolidated and are presented in Figure 14. Data include both parallel baghouse operations and field-on/field-off operation. Most data points are averages of 2 to 4 days of operation. There is a clear dependence of average drag on field strength at all face velocities tested, as well as a

TABLE 3. DRAG COMPARISONS OVER SIMILAR OPERATING PERIODS (COMPARISON OF TWO BAGHOUSES, ~1-MONTH-OLD BAGS, FIELD ON SOUTH BAGHOUSE, FIELD OFF NORTH BAGHOUSE)

Inclusive Julian date, day.year	Field strength, kV/cm	Face velocity, cm/s	Mean of average drags, kPa·s/cm	Ratio of field on/ off drags	Difference of field on/ off drags, kPa·s/cm
148.81-151.81	3.9	2.0	0.40	0.54	0.34
148.81-151.81	0	2.0	0.74		
191.81-196.81	3.6	1.5	0.56	0.66	0.29
191.81-196.81	0	1.5	0.85		
25.82-31.82	4.0	2.0	0.76	0.85	0.13
25.82-31.82	0	2.0	0.89		
Overall mean				0.68	0.25

TABLE 4. DRAG COMPARISONS OVER SIMILAR OPERATING PERIODS (SAME BAGHOUSE, BAGS, ELECTRODES, ~1-MONTH-OLD BAGS, SEQUENTIAL FIELD ON/OFF PERIODS)

Inclusive Julian date, day.year	Field strength, kV/cm	Face velocity, cm/s	Mean of average drags, kPa·s/cm		Ratio of field on/off drags	Difference of field on/off drags, kPa·s/cm
Standard bags, rigid electrodes						
246.82-249.82	2.8-3.8	1.25	1.44	1.46	0.89	0.18
256.82-260.82	3.8	1.25	1.49			
250.82-254.82	0	1.25	1.64			
Standard bags, rigid electrodes						
269.82-273.82	3.8	1.4	1.30		0.84	0.25
274.82-278.82	0	1.4	1.55			
Sewn spiral electrode bags						
343.82-349.82	2.2	1.5	1.16		0.92	0.10
350.82-356.82	0	1.5	1.26			
Sewn spiral electrode bags						
362.82-363.82	2.4	1.5	1.48		0.94	0.10
364.82-365.82	0	1.5	1.58			
Overall mean					0.90	0.16

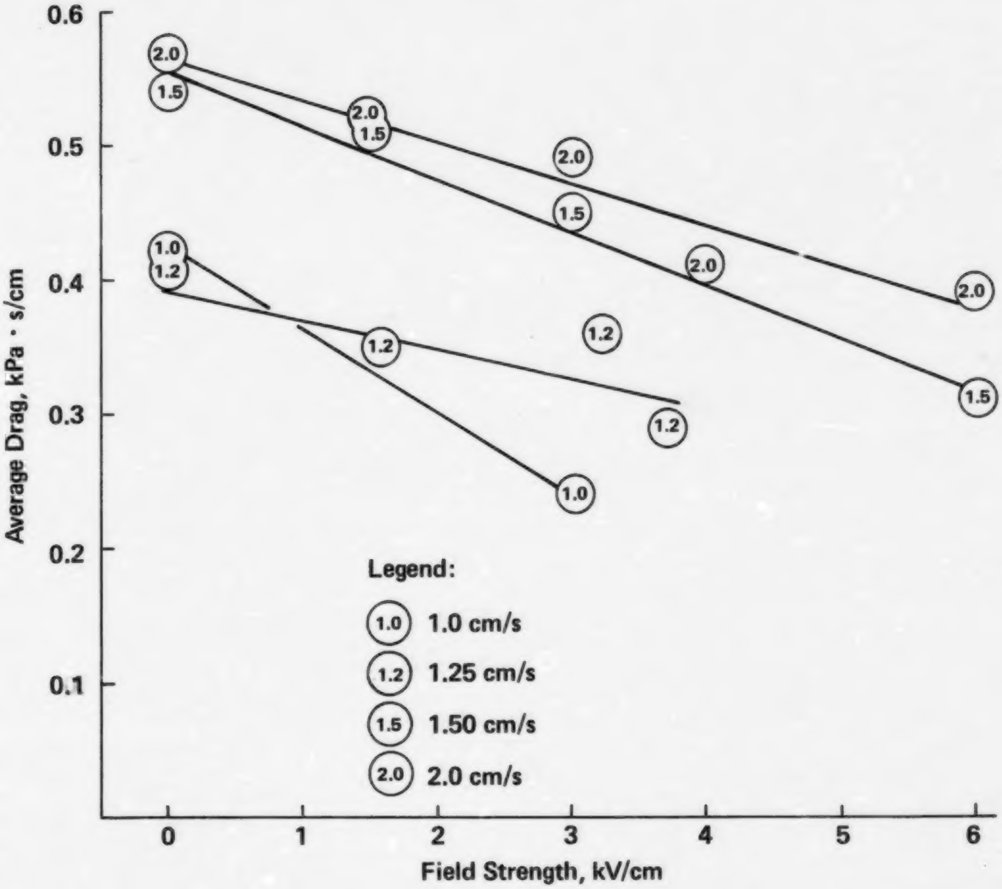


Figure 14. Drag as a function of field strength and face velocity.

significant dependence of average drag on face velocity. Halving the face velocity at any field strength reduces the average drag by 25 to 50 percent.

7.3 ELECTRIC POWER REQUIREMENTS

Over the entire pilot unit test program, the bag currents averaged about 130 μA/bag, or about 0.7 W/m^2 at an applied voltage of 5.4 kV. The monthly average currents ranged from 13 to 420 μA per bag, which is about 0.07 to 2.5 W/m^2.

ESFF performance was not related to bag current provided the electric field was kept on the bag. Sooty particles from oil firing and acid condensation caused high currents and reduced the power supply voltage. Under these conditions, there was no ESFF field on the bag, and no ESFF effect. Generally, it was possible to dry the bags and recover the ESFF effect.

7.4 DUST CAKE CHARACTERISTICS

Because the dust cake was on the inside of the reverse-air bag, direct observation of an undisturbed dust cake was impossible. The bag had to be removed from the thimble and partially folded for observation, which disturbed the dust cake. Within these limitations, the dust cake appeared uniform inside the bag. This was not true on the outside of the bag. Dark stripes were highly visible along the electrodes; usually the dust stripes along the positive electrode were somewhat different in color than those along the negative electrode. All electrode systems gave similar results. When this phenomenon was first observed with the rigid and flexible cages, it was thought that the stripes might be from increased penetration along the electrode bars from the contact of the bars and the fabric. However, the same phenomenon was observed with the sewn-on spiral electrodes and the woven electrodes, and current thinking is that this is simply charged dust being collected on the clean side of the bag as it penetrates. The coulombic forces are strong, and the net velocity away from the bag is low.

7.5 FLY ASH BULK PROPERTIES

7.5.1 Boiler Feed Coal Properties

The coal fed to the Waynesboro power house varied considerably over the course of the reverse-air test program. The coal was procured from several mines and was fed to the boilers without regard to source. Coal properties were analyzed only with a sample when the coal was received. Table 5 presents a summary of the analyses of four samples of coal received over a 2-week period in May 1982. The data are representative of normal variation in coal properties.

7.5.2 Other Fly Ash Properties

The pilot unit fly ash was not routinely analyzed in any way. During a period of higher than normal bag currents, however, several samples were analyzed for true density, total organic carbon, and resistivity. The density determination was made in a helium pycnometer, and the resistivity was determined using a cell at 4 kV/cm field strength, with bed depth of roughly 0.5 centimeter. The data did not correlate at all with ESFF performance, and Table 6 is presented only for completeness; it appears that in situ measurements will be required to achieve correlation with ESFF performance.

It is notable that while the true particle density was about 2.7 g/cm^3, the bulk density of the collected ash was found during the pulse-jet study to be about 0.23 g/cm^3 for dust collected in the ESFF baghouse, and 0.27 g/cm^3 in the conventional baghouse.

7.6 FLY ASH PARTICLE SIZE AND MASS LOADING

Gas particulate loading and particle size determinations were made only during specific test periods during the pilot unit test. Mass loadings were determined using standard EPA Method 5 procedures and equipment. The inlet loading data are presented in Figure 15. From the Method 5 test work, the average inlet loadings of the ESFF and control baghouses are identical within experimental error. The data indicate a slight dependence on baghouse face velocity, which is really a statement that the mass loading is a function of the total flow into the baghouses. For the pilot unit slipstream sampling nozzle, this is reasonable, as increased flow will bring in more large particles, which will raise the mass loading with a relatively small change in size distribution. The average inlet loading for the control baghouse was 1.31 g/m^3, while that for the ESFF baghouse was 1.27 g/m^3.

TABLE 5. COAL ANALYSIS SUMMARY

Coal:	A	B	C	D
Date sample received:	5/17/82	5/28/82	5/28/82	6/2/82
As-received analysis:				
Moisture, %	6.37	5.66	3.87	7.13
Ash, %	5.85	11.88	9.73	10.55
Volatile, %	36.43	32.00	30.42	32.12
Fixed carbon, %	51.35	50.46	55.98	50.20
Sulfur, %	1.24	0.79	2.36	0.74
Btu/lb	13,023	12,223	13,299	12,191
Ash softening temperature, °F	2,715	>2,800	2,253	>2,800
Grindability index	47	43	72	45

TABLE 6. SUMMARY OF MISCELLANEOUS WAYNESBORO ASH CHARACTERISTICS

Fly ash sample:	9/23/81	9/30/81	5/20/81	7/22/80
Particle density (g/cm^3)	2.79	2.69	Density not determined.	
Total organic carbon, %	14.6	10.1	18.3	10.1
Average resistivity at 4 kV/cm (Ω-cm)	9.2×10^{10}	1.07×10^{11}	2.9×10^{10}	7.8×10^{9}

[a] Determined by helium pycnometer.

[b] Determined under dry N^2 at room temperature, as a function of field strength.

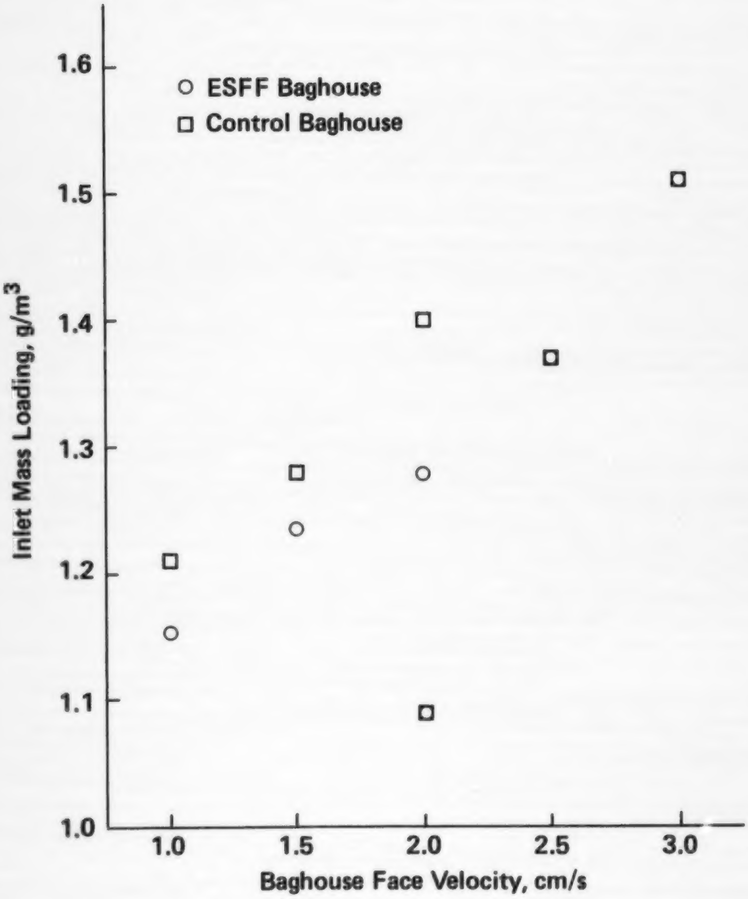


Figure 15. Inlet mass loading by Method 5.

The fly ash inlet particle size distribution was evaluated during a 1-week test program in May 1981. The test procedures have been included as Appendix B. During the test period, the baghouses were both operating as reverse-air baghouses at 1.75 cm/s, and the ESFF baghouse had a field strength of 2.2 kV/cm. Inlet data for the two testing days are presented in Figures 16 and 17 over the size range from ~0.07 to 10 μm using both cascade impactors and electrical aerosol analyzers (EAA) for particle sizing. The two instruments measure different particle properties, and lack of complete agreement is common. It is possible, however, that particle blowoff in the impactor raised the loading on the small cutpoint lower stages. Comparison of Figures 16 and 17 indicates that the inlet size distributions were fairly constant between the 2 days.

7.7 PARTICLE REMOVAL

7.7.1 Method 5 Test Results

The outlet loadings for both the control and ESFF baghouses were determined using standard EPA Method 5 procedures and equipment. The results are presented in Figure 18 as a function of face velocity. The overall average outlet loading for the conventional baghouse was 0.00272 g/m^3, while that for the ESFF baghouse was 0.00357 g/m^3. Although suggestive, this difference in outlet loadings is not significant at a 90-percent level of confidence. Neglecting the point at 1.5 cm/s brings the ESFF overall average down considerably, but the outlet loading for the ESFF baghouse would still be higher. Figure 19 is a plot of mass efficiency for the ESFF and conventional baghouses based on the Method 5 data. As was true with the pulse-jet baghouse test program, the mass removal efficiency of the ESFF baghouse is close but less than that of the conventional baghouse. The overall average efficiency for the ESFF baghouse was 99.7 percent, while that of the conventional baghouse was 99.8 percent.

7.7.2 Particle Removal as a Function of Size

The results of outlet particle size measurements on May 19 and 21, 1981, are presented in Figures 20 and 21, respectively. Figure 20 shows remarkable agreement between the EAA and impactor results for the ESFF baghouse. Although there is some scatter in Figure 21, it is clear that

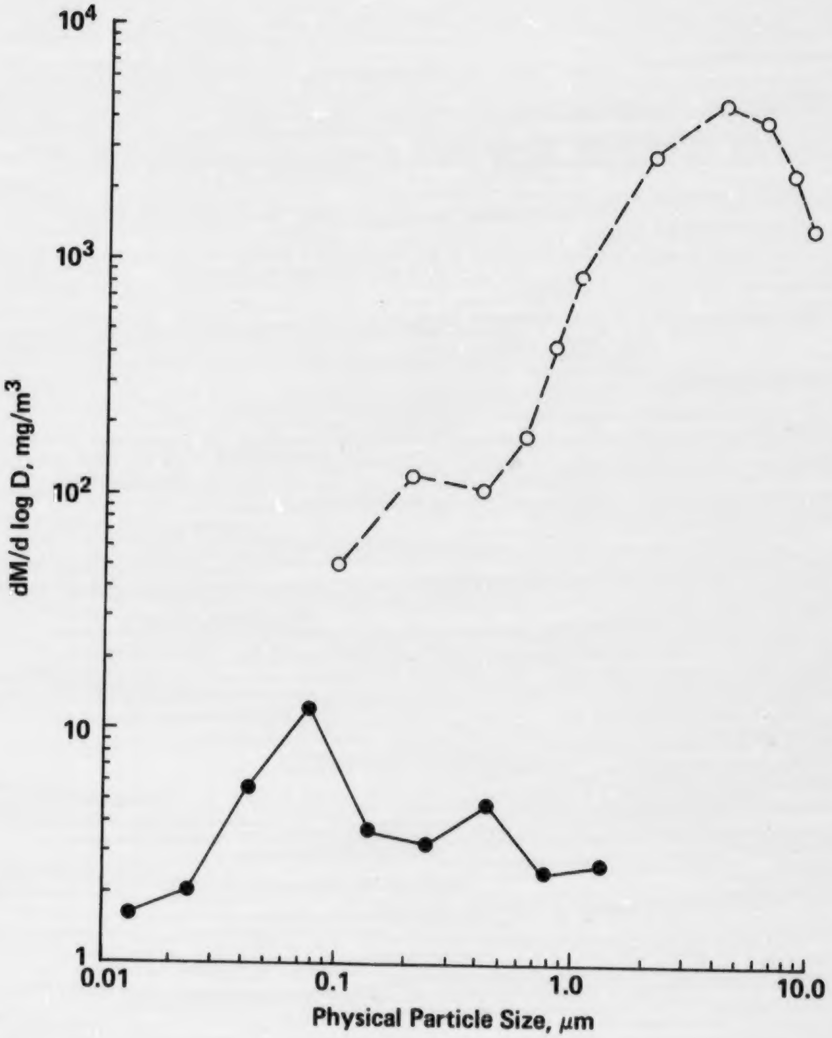


Figure 16. ESFF inlet differential mass plot, May 19, 1983.

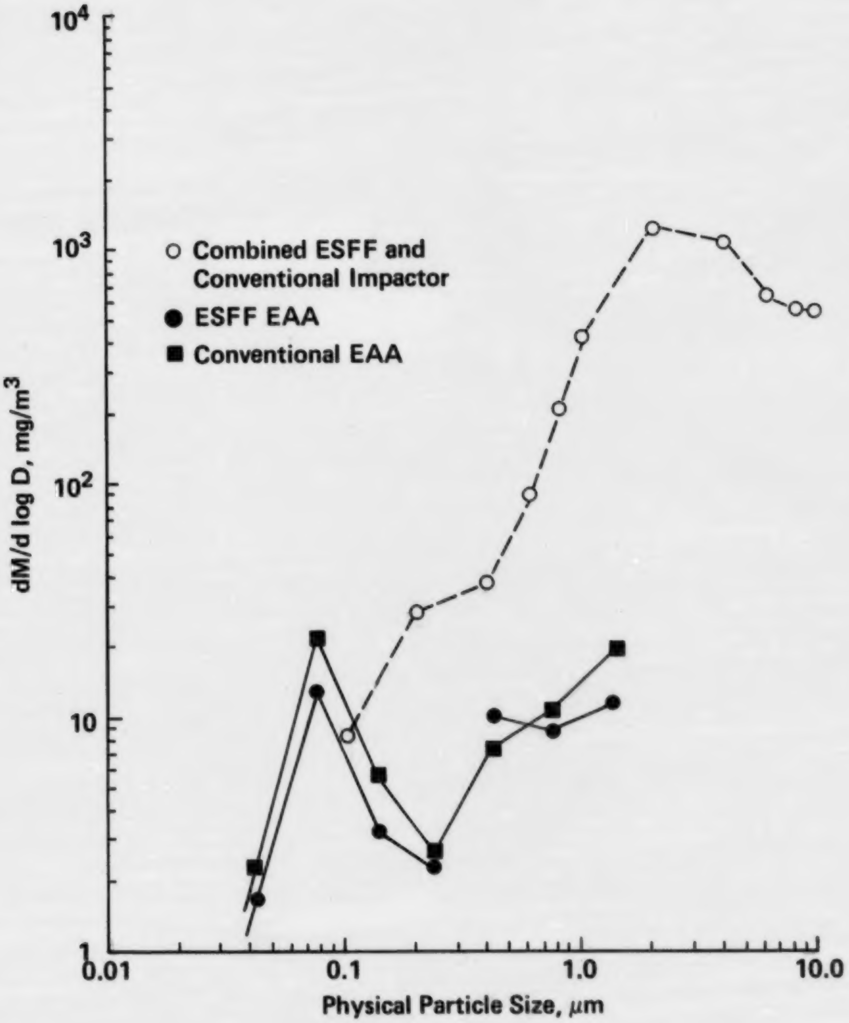


Figure 17. Inlet differential mass plot, May 21, 1983.

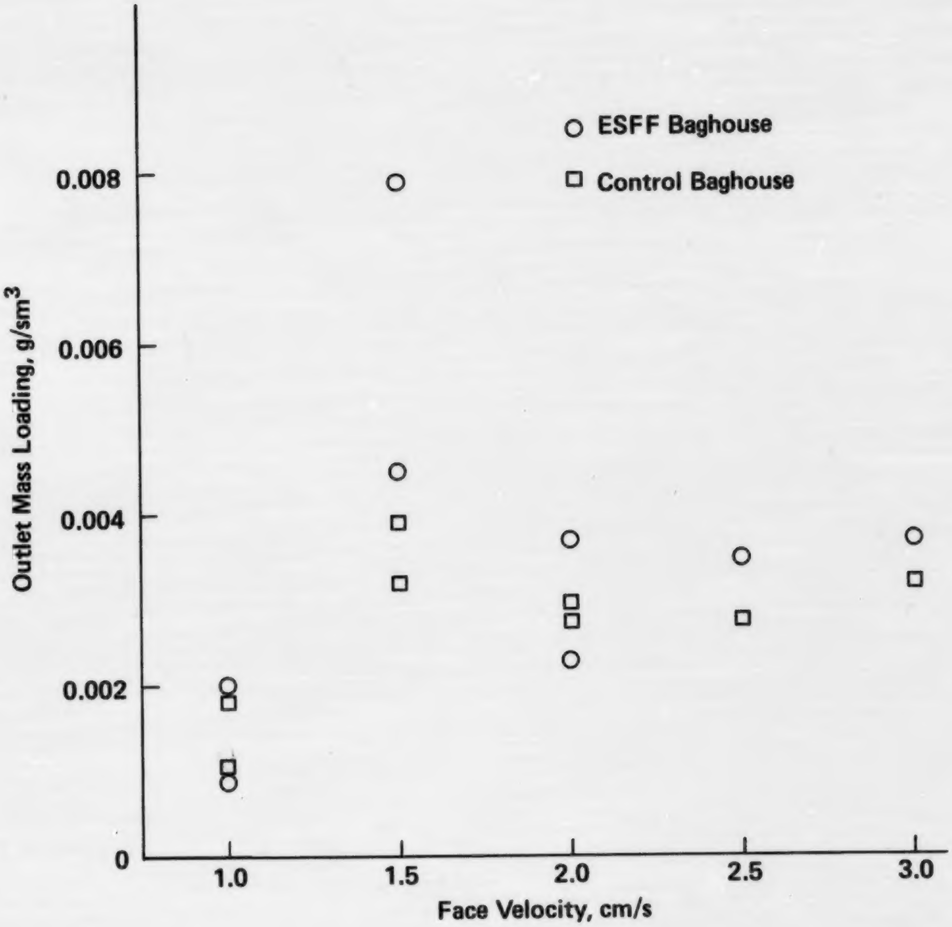


Figure 18. Pilot unit outlet loadings.

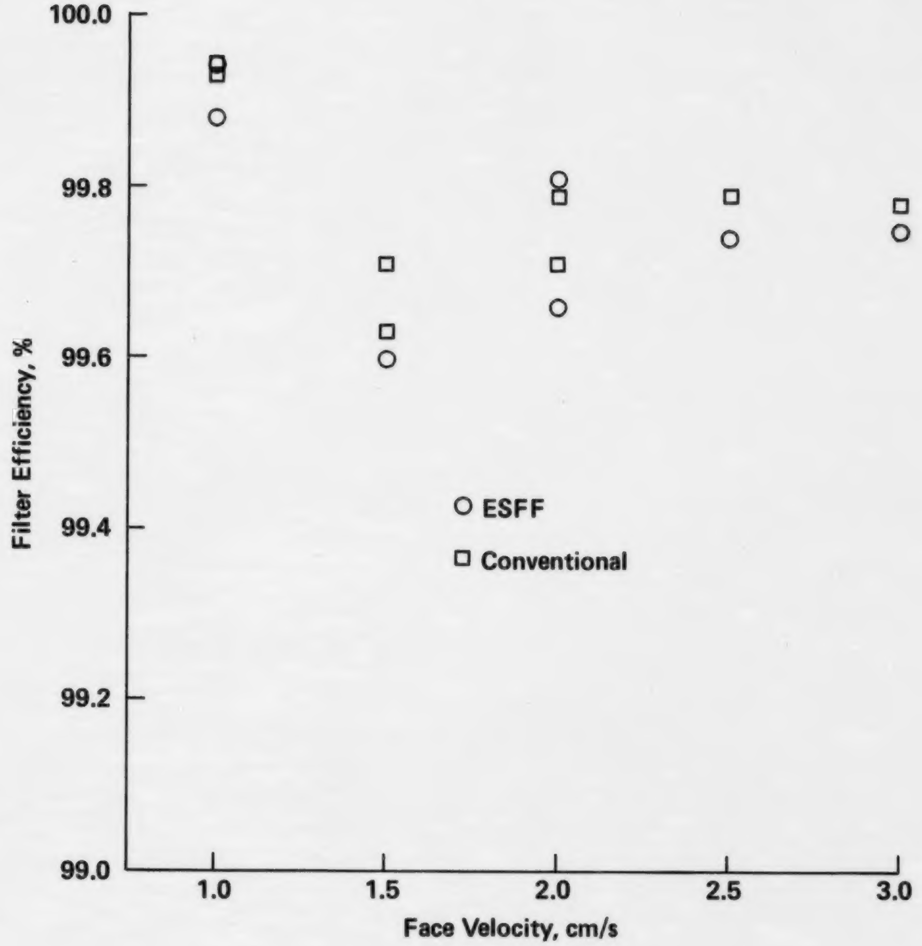


Figure 19. Mass removal efficiency.

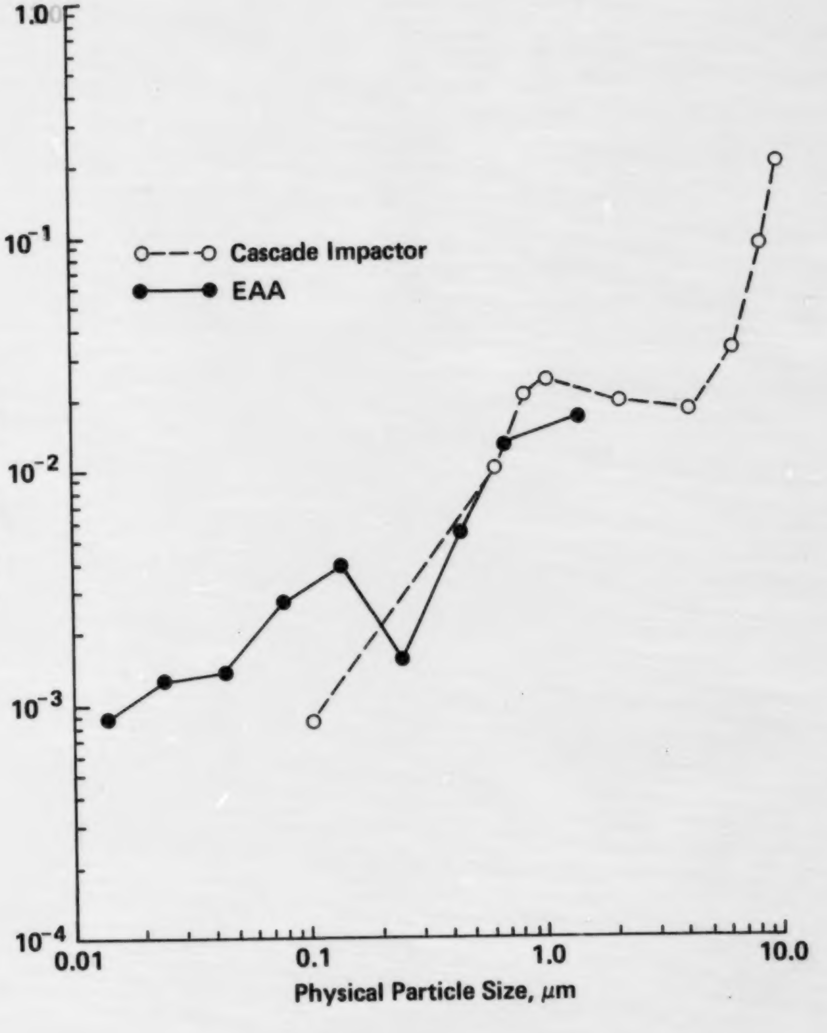


Figure 20. ESFF baghouse outlet differential mass plot, May 19, 1981.

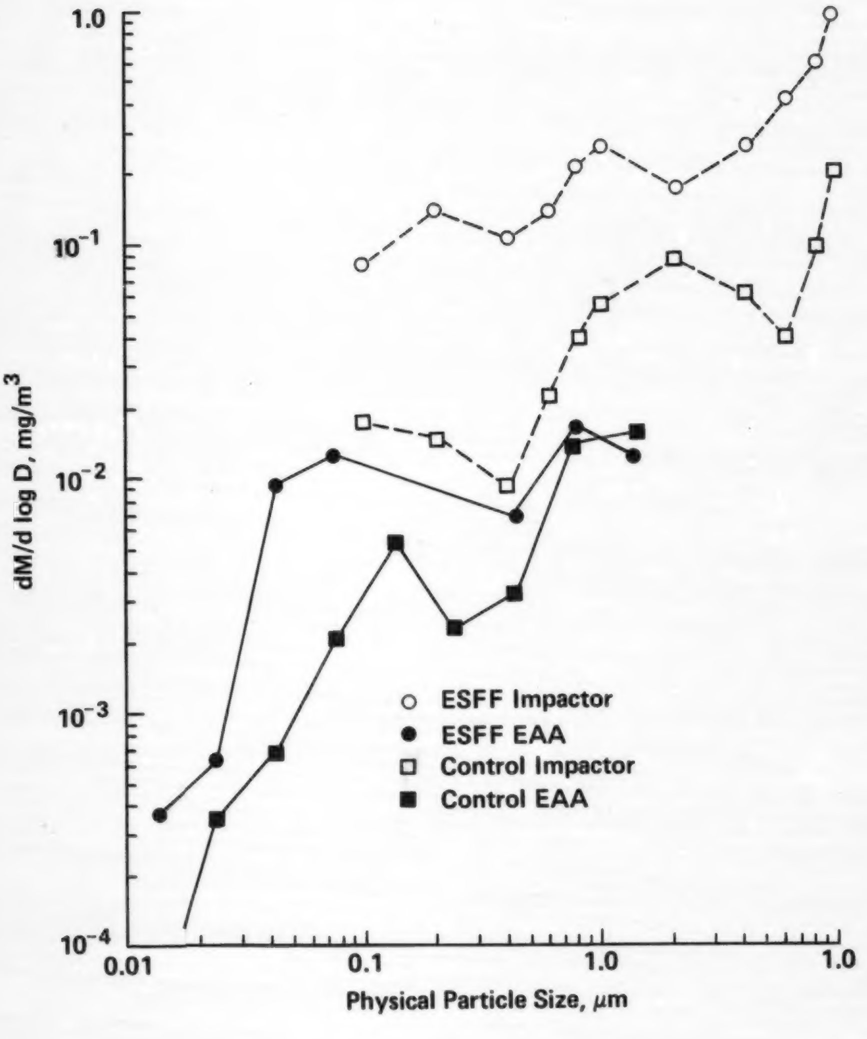


Figure 21. Baghouse outlet differential mass plots, May 21, 1983.

the ESFF baghouse has a uniformly higher outlet loading, although the difference is small. Figures 22 and 23 present fractional penetration data for the 2 days. Figure 23 indicates that the penetration is higher for the ESFF baghouse than for the conventional baghouse. The increased penetration below 0.1 μm in Figure 23 may be due to acid condensation in the sample lines, which were quite long.

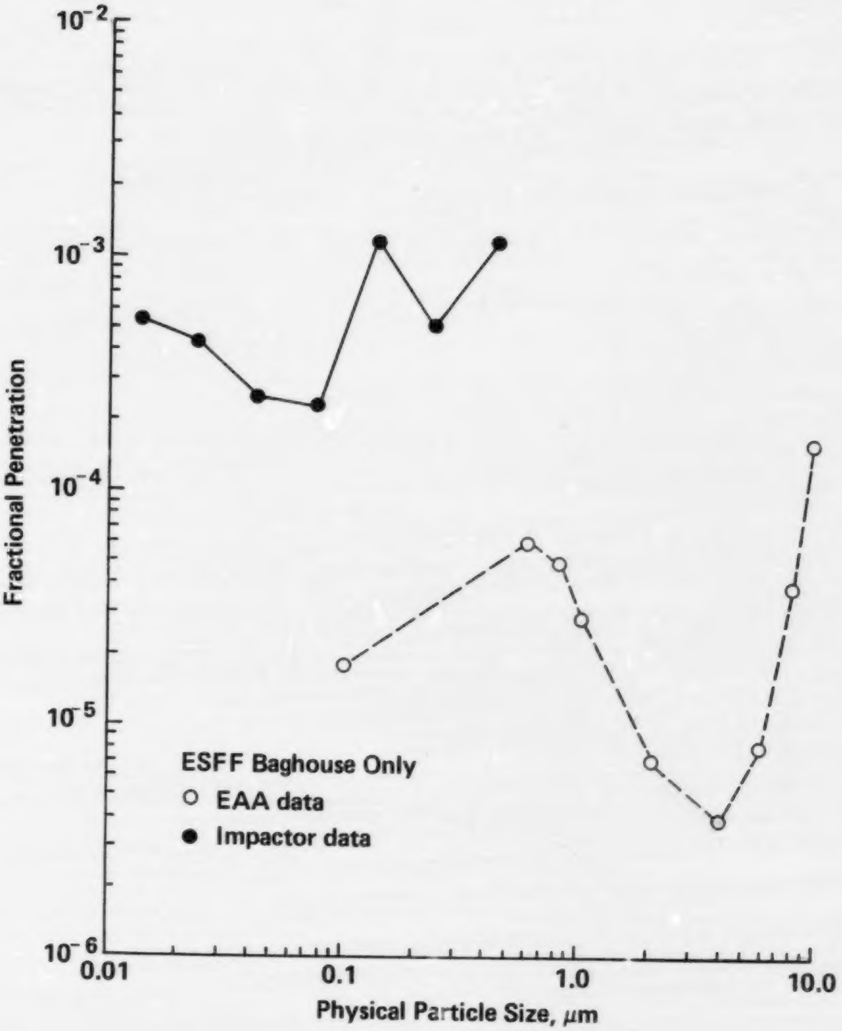


Figure 22. Fraction penetration, May 19, 1983.

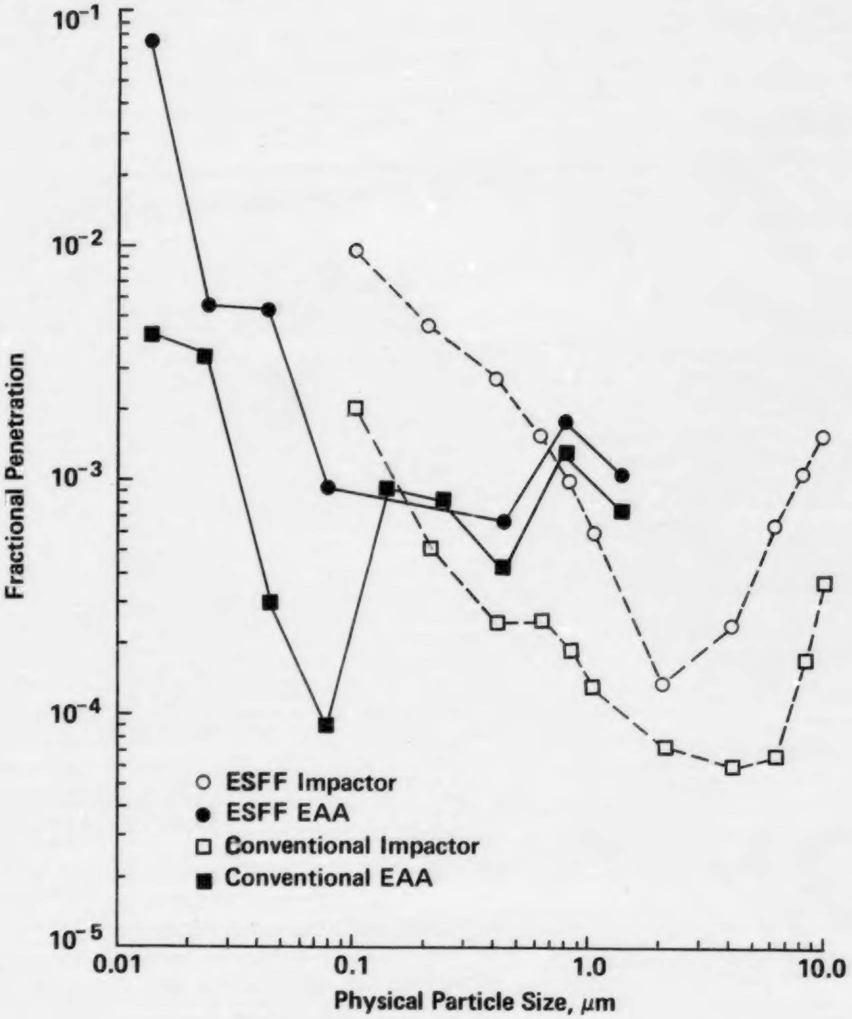


Figure 23. Fractional penetration, May 21, 1983.

SECTION 8

ECONOMICS

8.1 INTRODUCTION

The demonstrated improvements in pressure drop performance of an ESFF baghouse must be reflected in the economics of the unit to be of practical use. Two strategies to take advantage of ESFF have been considered:

1. Operate the baghouse at a conventional face velocity and cleaning frequency and achieve reduced fan power requirements because of the reduced pressure drop.
2. Size the baghouse to operate at the highest face velocity allowed with ESFF and at a pressure drop comparable to that of a conventional baghouse; obtain economic advantage from the reduced capital investment.

Either of these strategies would be possible for a particular application and set of operating conditions. For this report, the application of each strategy to only the electric utility industry is considered. The results of calculating the economics of each approach are presented. The economic model used was developed by Viner and Ensor,[13] and is described in detail in their report. This model was originally developed for three particle control technologies--scrubbers, electrostatic precipitators, and fabric filters. Only the fabric filter portion of the model was used, and a brief discussion of this portion of the model is presented here. The model was not modified for ESFF except to include the additional capital costs required. The major differences between ESFF and conventional baghouses can be expressed as differences in bag life, pressure drop, and cleaning frequency; these are used as inputs to the model to incorporate the differences due to ESFF.

8.2 FABRIC FILTER COST MODEL

8.2.1 Introduction

Capital costs can be divided into two categories: direct and indirect. Direct costs include such things as equipment, ducting, instrumentation, electrical and structural materials, insulation, site work, painting, and the associated cost of installation. Indirect costs include interest assessed during construction; contractors' fees and expenses; engineering, freight, and offsite expenses; and taxes, allowances, and contingencies.[14] The sum of the direct and indirect charges is called the total turnkey cost. Once the total turnkey cost has been determined, an annual capital cost can be determined. This is not an annualized cost, which is calculated as part of an investment analysis and is not considered here.

8.2.2 Direct Cost

For the purposes of this model, the total field cost of a control device was broken into three categories: fabric filter cost, induced draft fan cost, and ash pond cost. While the use of an ash pond is not often the most attractive disposal method for baghouse ash, it is a feasible method and its inclusion facilitates comparison with other studies. The fabric filter category of the model was further broken into several accounts:

1. Collector and supports: includes costs for the baghouse and hoppers, support steel, control room, inlet and outlet manifold, bypass dampers and duct, reverse-air fans, and hopper heaters.
2. Ducting and supports: includes costs for the boiler outlet duct, the ID fan inlet duct, expansion joints, and the duct support steel.
3. Ash handling system: includes cost of valves for each hopper and the cost of a positive pressure pneumatic ash-conveying system.
4. Insulation: includes cost of insulation for the baghouse, reverse-air fans, and all ducting.
5. Miscellaneous field charges: includes the cost of earthwork, concrete foundations, painting, and a contingency cost for the ID fan.

Accounts 1 through 4 include the cost of installation labor and materials.

The cost modeling equation for fabric filters is based on flow rate, air-to-cloth ratio, and the number of baghouse modules. The general equation is:

$$C_b = C_a \times \left(\frac{\text{flow rate}_b}{\text{flow rate}_a}\right)^f \times \left(\frac{AC_b}{AC_a}\right)^a \times \left(\frac{\text{modules}_b}{\text{modules}_a}\right)^m \qquad (4)$$

where

C = cost,

sub b represents the case under consideration,

sub a represents the base case,

flow rate = volumetric flow in the units specified,

AC = air-to-cloth ratio,

modules = number of baghouse modules,

super f, a, and m are exponents determined from data contained in Campbell[15] and presented in Table 7.

TABLE 7. MODEL PARAMETERS FOR MODEL FILTERS

Account	Base case cost[a] ($\$ \times 10^{-6}$)	f	a	m
Collector and supports	5.914	0.70	-0.70	0.22
Ducting and supports	0.827	0.72	0	0
Ash system	0.553	0.69	0	0.39
Insulation	1.550	0.61	-0.54	0.31
Misc. field charges	4.068	0.77	-0.47	0.22

[a] Base case: flow rate of 929.74 m^3/s @ 150° C, 709 mm Hg, air-to-cloth ratio of 0.55 m/min, 16 modules.

8.2.3 Induced Draft Fan

The induced draft (ID) fan cost is dependent on the flue gas flow rate and the maximum pressure drop across the control device. Unlike the cost of collector systems, there is no economy of scale when purchasing these fans. The following equation has been adapted from data reported by Ponder et al.:[14]

$$\text{fan cost} = \$80/\text{hp} \times \text{fan hp} \times 1.495 \times 1.2 \times \frac{215}{148.2} \ . \qquad (5)$$

This cost includes an indirect cost multiplier of 1.495 and a 20-percent contingency multiplier. The value of $80 per horsepower is in December 1973 dollars (CE Plant Cost Index = 148.2).[16] The fan cost has been updated to December 1978 dollars (CE Plant Cost Index = 215) to make it consistent with the collector system costs.

8.2.4 Ash Pond Cost

The cost of the ash pond is dependent on its size, which is determined by the amount of ash collected. This cost is also dependent on the presence or absence of a flue gas desulfurization (FGD) unit in the pollution control system. Only the portion of the ash pond needed for disposal of the baghouse fly ash is assigned to the baghouse for costing purposes. The amount of ash collected is the product of the amount of ash generated times the efficiency of the collector. The amount of fly ash generated in the boiler is calculated by:

$$\text{Ash generated} = \frac{\text{fraction fly ash} \times \text{boiler size}}{\text{coal heat value} \times \text{boiler efficiency}} \qquad (6)$$

where

Fraction fly ash = fraction of ash in coal that leaves boiler in flue gas,

Boiler size = net generating capacity,

Coal heat value = energy per unit mass,

Boiler efficiency = thermodynamic efficiency of energy conversion.

The amount of ash generated is calculated assuming 100 percent capacity; the pond size is calculated for the actual capacity factor:

$$\text{Pond size} = .08267 \times \text{ash collected} \times \text{capacity factor} \ . \qquad (7)$$

This equation yields pond size (acre-foot) assuming a pond life of 30 years. The constant, .08267 acre-ft/kg/h, is derived from data reported by Ponder et al.[14] The cost of the pond is calculated from the equation:

$$\text{Actual pond cost} = \$13{,}648 \times (\text{pond size})^{0.583} . \qquad (8)$$

Equation 9 was derived from Ponder's data[14] and includes the costs of land, excavating, and diking but does not include any charges for indirect costs or contingencies. The constant in Equation 8, $13,648, is the cost in dollars of a pond with 1 acre-ft of volume. These costs must be included to put the pond cost on the same basis as the equations for the baghouse model. The pond cost is adjusted for these factors using the following equation:

$$\begin{array}{c}\text{Total}\\ \text{pond}\\ \text{cost}\end{array} = \text{Actual pond cost} \times 1.395 \times 1.2 \times \frac{215}{148.2} \qquad (9)$$

where 1.395 is an indirect cost multiplier, the 1.2 adds a 20-percent contingency, and the ratio 215/148.2 adjusts the cost for escalation from December 1973 to the December 1978 of the other costs. The indirect cost multiplier in Equation 9 is less than the one used for the ID fan because the cost of the ash pond is mostly for labor; hence, some of the overhead, freight, and insurance charges can be eliminated.

8.2.5 Indirect Costs

After the total field cost has been estimated by summing the major cost elements, the total installed cost is determined by adding the cost of contingencies and engineering and fee to the total field cost. The contingency charge is included to account for unforeseen expenses. It does not include escalation. The engineering charge accounts for prime contractor engineering and fee. These costs are estimated as a fixed percentage of the total field cost; typically 20 percent.

8.2.6 Turnkey Costs

The turnkey cost for a baghouse is the sum of the costs of the installed equipment, the ID fan, and the ash pond. This turnkey cost may be updated to current dollars by multiplying by the ratio of the current CE Plant Cost Index to the December 1978 value (215).

8.3 ESFF COSTS

ESFF costs were added to the conventional baghouse model described above by designing a high voltage power supply and distribution system and incorporating its cost into the model. The design of the system was based on the pilot unit electrical system, except that less instrumentation was included. The added cost of ESFF bags is included by increasing the bag cost input to the model; for this work the cost of ESFF bags was estimated to be three times the cost of conventional bags, based on the cost of woven bags for the pilot unit.

8.4 RESULTS OF ECONOMIC STUDY

The baghouse cost model described above was applied to a 500-MW power plant case for both conventional fabric filtration and ESFF. Costs were estimated for both cases at face velocities of 1 and 2 cm/s. Conventional fabric filters are known not to be capable of operation at 2 cm/s; whether an ESFF filter can operate at that gas rate remains uncertain. Pilot unit operation at 2 cm/s was achieved without difficulty, but the maximum operating time was only a few weeks. The reduced drag of the ESFF baghouse over the entire test program suggests that increased face velocity operation is possible. The design pressure drops used in the model for the conventional baghouse were taken from pilot unit experience as presented in Figure 14. The ESFF pressure drops input to the model were taken indirectly from Figure 14; the data in Figure 14 were obtained primarily during field-on/field-off operation in a single baghouse. It was demonstrated in the data presented in Tables 3 and 4 that field-on/field-off operation understates the pressure drop advantage of an ESFF baghouse by a ratio of approximately 0.9/0.7. To account for this bias, the ESFF pressure drops taken from Figure 14 were multiplied by the fraction 0.7/0.9. The ESFF bags, based on pilot unit experience, are expected to cost two to four times as much as conventional bags, and this range is used in the ESFF cost estimates.

The cost estimates provided by the model are presented in Table 8 These data indicate that the electrical power savings associated with ESFF are not great enough to justify construction on that basis alone. For example, at 1 cm/s the reduction in operating costs with ESFF is only $30,000 out of a total annual cost of about $4,000,000 while the increased cost of building the ESFF unit is about $800,000.

Operation of an ESFF baghouse at an increased face velocity appears to be an attractive alternative, however, and pilot unit data indicate that such operation may be possible. An ESFF baghouse at 2 cm/s using bags costing three times conventional bags has a total annual cost of $3,430,000. Experience at the pilot unit suggests this to be a reasonable possibility. The bag cost may be excessive for a full-scale production operation. Pilot unit experience also suggests that ESFF bag life may not differ much from conventional bag life. A conventional unit at a normal and achievable 1 cm/s, controlling the same gas stream, has a total annual cost of $3,840,000, giving the ESFF baghouse an 11-percent cost advantage; at a bag cost of twice conventional bag cost, the advantage is 18 percent.

The comparisons above show that the ability to operate an ESFF baghouse at increased face velocities is the single most important variable in the economic analysis; ESFF bag cost is also seen to be critical.

TABLE 8. ESFF VERSUS CONVENTIONAL BAGHOUSE COST

	Cost (10^6 $)							
	Face velocity = 1 cm/s				Face velocity = 2 cm/s			
Baghouse description: Bag cost:	Conv. \$7/m^2	ESFF \$14/m^2	ESFF \$21/m^2	ESFF \$28/m^2	Conv. \$7/m^2	ESFF \$14/m^2	ESFF \$21/m^2	ESFF \$28/m^2
ESFF hardware	0	0.62	1.02	1.43	0	0.31	0.51	0.71
Collector and supports	5.85	5.86	5.86	5.86	3.64	3.65	3.65	3.65
Ducting and supports	0.87	0.87	0.87	0.87	0.86	0.87	0.87	0.87
Ash removal system	0.62	0.62	0.62	0.62	0.61	0.61	0.61	0.61
Insulation	1.60	1.60	1.60	1.60	1.10	1.10	1.10	1.10
Ash pond	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
ID fan	0.08	0.04	0.04	0.04	0.22	0.13	0.13	0.13
Miscellaneous	4.01	4.01	4.01	4.01	2.74	2.75	2.75	2.75
Total field cost	14.2	14.8	15.2	15.6	10.3	10.6	10.8	11.0
Engineering	2.83	2.95	3.03	3.11	2.06	2.11	2.15	2.19
Contingency	2.83	2.95	3.03	3.11	2.06	2.11	2.15	2.19
Turnkey cost	19.9	20.7	21.2	21.8	14.4	14.8	15.1	15.3
Fixed operating costs	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Variable operating costs	0.39	0.69	1.00	1.30	0.30	0.52	0.74	0.97
Cost of electricity	0.18	0.15	0.15	0.15	0.24	0.18	0.18	0.18
Annual capital cost	3.17	3.30	3.39	3.48	2.31	2.36	2.41	2.45
Total annual cost	3.84	4.24	4.64	5.03	2.95	3.16	3.43	3.70

Basis: 500-MW boiler, 720 am^3/s; conventional average pressure drop of 1.12 kPa at 2 cm/s, 0.42 kPa at 1 cm/s; ESFF pressure drop of 0.65 kPa at 2 cm/s, 0.19 kPa at 1 cm/s; interest rate of 15%/yr.

SECTION 9

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APPENDIX A

PILOT UNIT BAGHOUSE TEST SERIES DATA SUMMARIES

A.1 INTRODUCTION

Test work using the reverse-air ESFF pilot unit was in progress for nearly 2 years. During this time a number of test programs were conducted. The overall goal of the work was to test and demonstrate reverse-air ESFF. An important secondary goal was to develop the reverse-air ESFF hardware to facilitate speedy transfer of the technology to the private sector should it prove worthwhile. The test series were of two general types: short-term parametric studies and long-term performance testing. Each test series undertaken during the reverse-air pilot unit work is described below. Monthly summaries of the data taken during the test program are also presented as Tables A-1 through A-19.

A.2 SYSTEM STARTUP AND CHECKOUT

The reverse air baghouse was started up at full dust load (which is actually comparatively low) and at 1 cm/s (2 ft/min). Cleaning during this period was on a pressure drop setpoint to allow dust to accumulate on the bag. The bags used throughout the reverse-air program were constructed of a heavy, woven, fiberglass fabric. The break-in period began April 24, 1981, and continued through April 27, 1981.

A.3 BAGHOUSE TEST I: FACE VELOCITY PARAMETRIC STUDY

This initial test series was conducted with reverse-air operation in both baghouses, using the north baghouse as a control or conventional baghouse and the south baghouse as the electrically augmented test baghouse. This test was run from April 27 through mid-July, 1981.

The face velocity was increased sequentially by 0.5 cm/s (1 ft/min) each week throughout the test, working from 1 cm/s (2 ft/min) to 3 cm/s (6 ft/min). This approach was used rather than a randomized experiment to allow a test at all face velocities without risking bag blinding early in the test program because of dust overload at the high face velocity. At the close of the sequential test program, the low face velocity data were replicated to determine the drift in the residual pressure drop during the test.

A.4 FINE PARTICLES TEST PROGRAM

A fine particles test program was carried out in the midst of Baghouse Test Series I. The purpose of the test was to determine the particle size spectrum at the pilot unit and to compare size-dependent particle removal for the conventional and ESFF baghouses. The test covered the particle size spectrum from .03 to about 10 micrometers through the use of cascade impactors and electrical aerosol analyzers. A description of the test program and operating procedures are provided in Appendix B. During the fine particle test, the baghouses were operated at 1.5 cm/s (3 ft/min), and the ESFF field was maintained at 2.6 kV/cm. Both baghouses were cleaned on the same schedule. The test program was conducted during the week of May 18-22, 1981.

A.5 BAGHOUSE TEST II: FIELD STRENGTH PARAMETRIC STUDY

The purpose of the second test series was to study the effect of the electric field strength on the ESFF effect. This test was to be run at 2 cm/s (4 ft/min) in both baghouses, with field strengths of 0, 2, 4, and 6 kV/cm. Because the rigid cages shorted before achieving 6 kV/cm, this test series made use of the flexible cage. The test work was run between July 26, 1981, and October 19, 1981.

A.6 BAGHOUSE TEST SERIES III: BAGHOUSE COMPARISON STUDY

Certain of the results obtained during Test II indicated that the two baghouses were no longer behaving as identical baghouses in parallel. Test III was initiated to determine the scope of the problem and a possible solution. This comparison study was in progress from about November 1, 1981 through March 17, 1982. The upshot of the test was that the pressure drop results had become biased in favor of the ESFF baghouse largely because of the cleaning cycle, and the cleaning system was modified to permit the use of clean air as reverse air.

A.7 BAGHOUSE TEST SERIES IV: REPEAT PARAMETRIC EVALUATION

A new parametric study of reverse-air ESFF was undertaken to reevaluate the operating data of June and July 1981. New bags were installed in both the ESFF and control baghouses, broken in, and operated from March 17, 1982, through June 30, 1982. Various upsets at the boilerhouse during this test program--particularly large amounts of soot on recently installed pilot unit bags--caused high pressure drops. The bags were replaced twice during this operating period. Because of these upsets, the test bags during March and April 1982 did not run long enough to provide useful data, and data tables for these months are not included. The bags used to collect data for this repeat parametric evaluation were installed about April 15, 1982; valid performance data can be obtained after 2 weeks of operation as reported in the May 1982 data.

A.8 BAGHOUSE TEST SERIES V: LONG-TERM ESFF TEST

This test series made use of the pilot unit as two separate reverse-air baghouses. The north baghouse was used to continue reverse-air operation with rigid cages and heavy-weight woven fiberglass. The south baghouse was used to evaluate a number of other options. The long-term ESFF test program was run in the north baghouse from June 30, 1982, through October 7, 1982. The face velocity was 2 cm/s (4 ft/min) and the field strength was maintained at 3 kV/cm. The south baghouse was operated with a woven electrode fabric for the month of July 1982. This fabric was a woven Teflon fabric with a conductive nylon yarn woven into the fabric at 2-cm spacing. As was expected, the nylon yarn failed after about a month in the flue gas environment, but the test provided valuable experience with woven electrode bags and provided the first pilot unit data for reverse-air ESFF with the woven electrodes. The south baghouse was converted to pulse-jet operation following the woven electrode test and was operational by August 15, 1982.

A.9 BAGHOUSE TEST SERIES VI: PULSE-JET OPERATION

One pilot unit baghouse was converted back to pulse-jet operation to permit the evaluation of the ceramic, insulated, pulse-jet cages and to make efficient use of pilot plant operating time. The south baghouse was operational as a pulse-jet baghouse by August 15, 1982, and was operated through the end of December 1982.

A.10 BAGHOUSE TEST SERIES VII: SPIRAL ELECTRODE BAG/PRECHARGER

An electrode design that had not been tested was that using two continuous wire electrodes spiraled down a bag in a double helix with 2-cm spacing between the electrodes. The advantage of this design is that the electrodes can be sewn on a completed bag. The spiral electrodes were installed October 8, 1982, and were in operation through January 24, 1983. In addition, a precharger was installed in the baghouse October 20, 1982, and was tested with the spiral electrode bag.

A.11 BAGHOUSE TEST SERIES VIII: WOVEN ELECTRODE BAG OPERATION; PRECHARGER

Woven fiberglass bags with woven-in stainless steel warp yarns 2 cm apart were installed in the pilot unit north baghouse January 24, 1983. These bags were broken in at 1 cm/s (2 ft/min) at 3 kV/cm and then started in the test program on January 28. A corona precharger made of wire filaments arranged in a conical shape was mounted base upwards in the thimble.

The precharger appeared to have a beneficial effect on pressure drop until the first cleaning cycle, after which it had very little effect. Investigation revealed that the precharger became heavily coated with dust and apparently ceased to function. As the precharger test was only peripheral to the test program, the test was abandoned.

A.12 DATA TABLES

The data in Tables A-1 through A-19 summarize the bulk of the reverse-air test work. Each data point is from a single cleaning cycle during the indicated day. The Julian date is given with the day number and year separated by a period. The status column indicates whether the baghouse was in reverse-air (RA) or pulse-jet (PJ) operating mode. The electric field is the nominal field strength calculated as potential on the electrode divided by electrode spacings in kV/cm. Pressure drops are all expressed in kPa. Tables A-1 through A-6 provide the residual and "average" pressure drop (deltap) for both baghouses. This "average" pressure drop is actually the average of the residual and final pressure drops, and is the true average only if the pressure drop rise curve is linear. Tables A-7 through A-19 provide the residual, extrapolated, and final pressure drops. The face velocity and cleaning cycle columns are self-explanatory. The drags were calculated as the respective pressure drop divided by the face velocity in cm/s.

TABLE A-1. DATA SUMMARY FOR APRIL 1981

Julian Date day.year	South Baghouse Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Average kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm
91.81									
92.81									
93.81									
94.81									
95.81									
96.81									
97.81	Baghouse Conversion to Reverse-Air Operation								
98.81									
99.81									
100.81									
101.81									
102.81									
103.81									
104.81									
105.81									
106.81									
107.81									
108.81									
109.81									
110.81									
111.81									
112.81									
113.81									
114.81	Bags Installed, Baghouse Started-Up								
115.81	Break-in Period								
116.81	Break-in Period								
117.81	RA	1.60	40.00	0.16	0.27	1.00	240.00	0.16	0.27
118.81	RA	2.00	100.00	0.14	0.29	1.00	240.00	0.14	0.29
119.81	RA	2.00	100.00	0.18	0.32	1.00	240.00	0.18	0.32
120.81	RA	2.00	100.00	0.22	0.34	1.00	240.00	0.22	0.34
Averages	RA	1.90	85.00	0.18	0.31	1.00	240.00	0.18	0.31

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TABLE A-1 (continued)

North Baghouse										
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Average kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Pressure Drop Ratio
91.81										
92.81										
93.81										
94.81										
95.81										
96.81										
97.81		Baghouse Conversion to Reverse-Air Operation								
98.81										
99.81										
100.81										
101.81										
102.81										
103.81										
104.81										
105.81										
106.81										
107.81										
108.81										
109.81										
110.81										
111.81										
112.81										
113.81										
114.81	Bags Installed, Baghouse Started-Up									
115.81	Break-in Period									
116.81	Break-in Period									
117.81	RA	0.00	0.00	0.34	0.58	1.00	240.00	0.34	0.58	0.63
118.81	RA	0.00	0.00	0.30	0.55	1.00	240.00	0.30	0.55	0.50
119.81	RA	0.00	0.00	0.33	0.61	1.00	240.00	0.33	0.61	0.50
120.81	RA	0.00	0.00	0.31	0.58	1.00	240.00	0.31	0.58	0.43
Averages	RA	0.00	0.00	0.32	0.58	1.00	240.00	0.32	0.58	0.51

TABLE A-2. DATA SUMMARY FOR MAY 1981

				South Baghouse					
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Average kPa	Face Velocity .cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm
121.81	RA	2.10	90.00	0.24	0.39	1.00	240.00	0.24	0.39
122.81	RA	2.10	90.00	0.28	0.48	1.00	240.00	0.28	0.48
123.81	RA	2.20	82.00	0.28	0.43	1.00	240.00	0.28	0.43
124.81	RA	2.35	75.00	0.24	0.39	1.00	240.00	0.24	0.39
125.81	RA	2.30	75.00	0.23	0.35	1.00	240.00	0.23	0.35
126.81	RA	2.40	75.00	0.25	0.36	1.00	240.00	0.25	0.36
127.81	RA	2.40	75.00	0.24	0.35	1.00	240.00	0.24	0.35
128.81	RA	2.45	67.00	0.24	0.35	1.00	240.00	0.24	0.35
129.81	RA	2.30	75.00	0.25	0.36	1.00	240.00	0.25	0.36
130.81	RA	2.30	75.00	0.25	0.36	1.00	240.00	0.25	0.36
131.81	RA	2.40	75.00	0.24	0.36	1.00	240.00	0.24	0.36
132.81	RA	0.00	0.00	0.31	0.69	1.50	240.00	0.21	0.46
133.81	RA	1.40	40.00	0.25	0.61	1.50	240.00	0.17	0.41
134.81	RA	2.00	45.00	0.25	0.45	1.50	240.00	0.17	0.30
135.81	RA	2.25	37.00	0.27	0.44	1.50	240.00	0.18	0.29
136.81	RA	2.30	35.00	0.28	0.46	1.50	240.00	0.19	0.31
137.81	RA	2.35	32.00	0.28	0.45	1.50	240.00	0.19	0.30
138.81	RA	2.40	30.00	0.38	0.58	1.50	240.00	0.25	0.39
139.81	RA	2.35	32.00	0.41	0.75	1.25	180.00	0.33	0.60
140.81	Data Not Available								
141.81	Data Not Available								
142.81	RA	2.75	25.00	0.13	0.16	0.50	180.00	0.26	0.32
143.81	RA	2.70	25.00	0.13	0.18	0.50	180.00	0.26	0.36
144.81	RA	2.70	25.00	0.13	0.18	0.50	180.00	0.26	0.36
145.81	RA	2.70	25.00	0.13	0.18	0.50	180.00	0.26	0.36
146.81	System Down For Maintenance								
147.81	RA	3.90	10.00	0.06	0.09	0.50	180.00	0.12	0.18
148.81	RA	3.95	10.00	0.41	0.75	2.00	180.00	0.21	0.38
149.81	RA	3.80	15.00	0.47	0.91	2.00	180.00	0.24	0.46
150.81	RA	3.95	5.00	0.46	0.74	2.00	180.00	0.23	0.37
151.81	RA	4.00	5.00	0.48	0.73	2.00	180.00	0.24	0.37
Averages	RA	2.53	44.64					0.23	0.37

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TABLE A-2 (continued)

				North Baghouse						
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Average kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Pressure Drop Ratio
121.81	RA	0.00	0.00	0.32	0.54	1.00	240.00	0.32	0.54	0.56
122.81	RA	0.00	0.00	0.38	0.68	1.00	240.00	0.38	0.68	0.68
123.81	RA	0.00	0.00	0.44	0.75	1.00	240.00	0.44	0.75	0.55
124.81	RA	0.00	0.00	0.31	0.69	1.00	240.00	0.31	0.69	0.59
125.81	RA	0.00	0.00	0.31	0.56	1.00	240.00	0.31	0.56	0.65
126.81	RA	0.00	0.00	0.25	0.56	1.00	240.00	0.25	0.56	0.52
127.81	RA	0.00	0.00	0.28	0.56	1.00	240.00	0.28	0.56	0.50
128.81	RA	0.00	0.00	0.28	0.54	1.00	240.00	0.28	0.54	0.53
129.81	RA	0.00	0.00	0.28	0.54	1.00	240.00	0.28	0.54	0.53
130.81	RA	0.00	0.00	0.28	0.55	1.00	240.00	0.28	0.55	0.55
131.81	RA	0.00	0.00	0.28	0.55	1.00	240.00	0.28	0.55	0.62
132.81	RA	0.00	0.00	0.43	0.80	1.50	240.00	0.29	0.53	1.00
133.81	RA	0.00	0.00	0.47	0.90	1.50	240.00	0.31	0.60	0.68
134.81	RA	0.00	0.00	0.49	0.94	1.50	240.00	0.33	0.63	0.50
135.81	RA	0.00	0.00	0.48	0.95	1.50	240.00	0.32	0.63	0.48
136.81	RA	0.00	0.00	0.47	0.98	1.50	240.00	0.31	0.65	0.42
137.81	RA	0.00	0.00	0.50	0.95	1.50	240.00	0.33	0.63	0.47
138.81	RA	0.00	0.00	0.63	1.06	1.50	240.00	0.42	0.71	0.49
139.81	RA	0.00	0.00	0.66	1.25	1.25	180.00	0.53	1.00	0.58
140.81					Data Not Available					
141.81					Data Not Available					
142.81	RA	0.00	0.00	0.20	0.45	0.50	180.00	0.40	0.90	0.26
143.81	RA	0.00	0.00	0.20	0.48	0.50	180.00	0.40	0.96	0.29
144.81	RA	0.00	0.00	0.22	0.48	0.50	180.00	0.44	0.96	0.21
145.81	RA	0.00	0.00	0.23	0.48	0.50	180.00	0.46	0.96	0.27
146.81					System Down For Maintenance					
147.81	RA	0.00	0.00	0.19	0.25	0.50	180.00	0.38	0.50	0.25
148.81	RA	0.00	0.00	0.83	1.43	2.00	180.00	0.42	0.72	0.66
149.81	RA	0.00	0.00	0.96	1.51	2.00	180.00	0.48	0.76	0.72
150.81	RA	0.00	0.00	0.94	1.46	2.00	180.00	0.47	0.73	0.72
151.81	RA	0.00	0.00	0.97	1.45	2.00	180.00	0.49	0.73	0.68
Averages	RA	0.00	0.00					0.36	0.68	0.53

TABLE A-3. DATA SUMMARY FOR JUNE 1981

South Baghouse									
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Average kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm
152.81	RA	4.00	5.00	0.48	0.74	2.00	180.00	0.24	0.37
153.81	RA	4.00	5.00	0.50	0.78	2.00	180.00	0.25	0.39
154.81	RA	4.00	5.00	0.50	0.78	2.00	180.00	0.25	0.39
155.81	RA	4.00	5.00	0.66	1.04	2.50	180.00	0.26	0.42
156.81	RA	3.90	10.00	0.73	1.09	2.50	180.00	0.29	0.44
157.81	RA	3.20	33.00	0.73	1.06	2.50	180.00	0.29	0.42
158.81	RA	2.30	58.00	0.70	1.00	2.50	180.00	0.28	0.40
159.81	RA	3.40	42.00	0.56	0.75	2.50	180.00	0.22	0.30
160.81	RA	2.80	40.00	1.00	1.38	3.00	120.00	0.33	0.46
161.81	RA	2.40	58.00	1.03	1.40	3.00	120.00	0.34	0.47
162.81	RA	2.30	50.00	1.13	1.53	3.00	120.00	0.38	0.51
163.81	RA	2.40	42.00	1.13	1.46	3.00	120.00	0.38	0.49
164.81	RA	2.60	30.00	1.14	1.46	3.00	120.00	0.38	0.49
165.81	RA	2.60	33.00	1.18	1.51	3.00	120.00	0.39	0.50
166.81	RA	3.40	20.00	1.20	1.55	3.00	120.00	0.40	0.52
167.81	RA	3.30	20.00	1.24	1.59	3.00	120.00	0.41	0.53
168.81	RA	3.40	20.00	1.28	1.63	3.00	120.00	0.43	0.54
169.81	RA	3.40	10.00	1.33	1.68	3.00	120.00	0.44	0.56
170.81	RA	3.60	5.00	1.28	1.60	3.00	120.00	0.43	0.53
171.81	RA	3.60	5.00	1.38	1.70	3.00	120.00	0.46	0.57
172.81	RA	3.60	5.00	1.36	1.71	3.00	120.00	0.45	0.57
173.81	RA	3.60	12.00	1.25	1.63	3.00	120.00	0.42	0.54
174.81	RA	3.40	35.00	1.30	1.66	3.00	120.00	0.43	0.55
175.81	RA	3.60	12.00	1.37	1.75	3.00	120.00	0.46	0.58
176.81	RA	3.40	25.00	1.26	1.65	3.00	120.00	0.42	0.55
177.81	RA	3.40	25.00	1.31	1.75	3.00	120.00	0.44	0.58
178.81	RA	3.60	5.00	1.45	1.91	3.00	120.00	0.48	0.64
179.81	RA	3.60	12.00	1.54	1.95	3.00	120.00	0.51	0.65
180.81	RA	3.20	20.00	1.30	1.63	3.00	120.00	0.43	0.54
181.81	RA	3.00	38.00	1.33	1.68	3.00	120.00	0.44	0.56
Averages	RA	3.30	22.83					0.38	0.50

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TABLE A-3 (continued)

North Baghouse										
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Average kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Pressure Drop Ratio
152.81	RA	0.00	0.00	0.94	1.51	2.00	180.00	0.47	0.76	0.63
153.81	RA	0.00	0.00	0.97	1.63	2.00	180.00	0.49	0.82	0.63
154.81	RA	0.00	0.00	1.00	1.55	2.00	180.00	0.50	0.78	0.60
155.81	RA	0.00	0.00	1.05	1.65	2.00	180.00	0.53	0.83	0.58
156.81	RA	0.00	0.00	1.07	1.59	2.00	180.00	0.54	0.80	0.50
157.81	RA	0.00	0.00	1.08	1.58	2.00	180.00	0.54	0.79	0.45
158.81	RA	0.00	0.00	1.07	1.53	2.00	180.00	0.54	0.77	0.55
159.81	RA	0.00	0.00	1.01	1.46	2.00	180.00	0.51	0.73	0.30
160.81	RA	0.00	0.00	1.33	1.88	2.20	120.00	0.60	0.85	0.45
161.81	RA	0.00	0.00	1.47	1.98	2.20	120.00	0.67	0.90	0.40
162.81	RA	0.00	0.00	2.05	2.51	2.20	120.00	0.93	1.14	0.45
163.81	RA	0.00	0.00	2.19	2.63	2.20	120.00	1.00	1.20	0.42
164.81	RA	0.00	0.00	2.26	2.73	2.20	120.00	1.03	1.24	0.38
165.81	RA	0.00	0.00	2.28	2.79	2.20	120.00	1.04	1.27	0.36
166.81	RA	0.00	0.00	1.39	1.88	1.50	120.00	0.93	1.25	0.25
167.81	RA	0.00	0.00	1.42	1.85	1.50	120.00	0.95	1.23	0.25
168.81	RA	0.00	0.00	1.45	1.86	1.50	120.00	0.97	1.24	0.25
169.81	RA	0.00	0.00	1.59	1.94	1.50	120.00	1.06	1.29	0.31
170.81	RA	0.00	0.00	1.54	1.88	1.50	120.00	1.03	1.25	0.32
171.81	RA	0.00	0.00	1.61	2.00	1.50	120.00	1.07	1.33	0.32
172.81	RA	0.00	0.00	1.63	2.00	1.50	120.00	1.09	1.33	0.35
173.81	RA	0.00	0.00	1.52	1.93	1.50	120.00	1.01	1.29	0.35
174.81	RA	0.00	0.00	1.58	1.99	1.50	120.00	1.05	1.33	0.36
175.81	RA	0.00	0.00	1.61	2.04	1.50	120.00	1.07	1.36	0.40
176.81	RA	0.00	0.00	1.55	1.96	1.50	120.00	1.03	1.31	0.38
177.81	RA	0.00	0.00	1.59	2.01	1.50	120.00	1.06	1.34	0.34
178.81	RA	0.00	0.00	1.64	2.08	1.50	120.00	1.09	1.39	0.46
179.81	RA	0.00	0.00	1.64	2.14	1.50	120.00	1.09	1.43	0.40
180.81	RA	0.00	0.00	1.50	1.95	1.50	120.00	1.00	1.30	0.31
181.81	RA	0.00	0.00	1.54	1.99	1.50	120.00	1.03	1.33	0.28
Averages	RA	0.00	0.00					0.86	1.13	0.40

TABLE A-4. DATA SUMMARY FOR JULY 1981

				South Baghouse					
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Average kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm
182.81	RA	3.00	30.00	1.41	1.71	3.00	120.00	0.47	0.57
183.81	RA	3.00	20.00	1.44	1.74	3.00	120.00	0.48	0.58
184.81	RA	3.20	20.00	1.51	1.81	3.00	120.00	0.50	0.60
185.81	RA	3.20	25.00	1.55	1.84	3.00	120.00	0.52	0.61
186.81	RA	3.10	35.00	1.51	1.79	3.00	120.00	0.50	0.60
187.81	RA	3.40	15.00	0.24	0.28	1.00	120.00	0.24	0.28
188.81	RA	3.40	10.00	0.28	0.30	1.00	120.00	0.28	0.30
189.81	RA	3.60	5.00	0.33	0.38	1.50	120.00	0.22	0.25
190.81	RA	3.60	5.00	0.48	0.65	2.00	120.00	0.24	0.33
191.81	RA	3.60	5.00	0.45	0.54	1.50	120.00	0.30	0.36
192.81	RA	3.60	5.00	0.50	0.60	1.50	120.00	0.33	0.40
193.81	RA	3.60	5.00	0.50	0.60	1.50	120.00	0.33	0.40
194.81	RA	3.60	5.00	0.50	0.60	1.50	120.00	0.33	0.40
195.81	RA	3.60	5.00	0.49	0.59	1.50	120.00	0.33	0.39
196.81	RA	3.60	5.00	0.53	0.61	1.50	120.00	0.35	0.41
197.81				Baghouses Down For Maintenance					
198.81				Baghouses Down For Maintenance					
199.81				Baghouses Down For Maintenance					
200.81				Baghouses Down For Maintenance					
201.81				Baghouses Down For Maintenance					
202.81				Baghouses Down For Maintenance					
203.81				Baghouses Down For Maintenance					
204.81				Baghouses Down For Maintenance					
205.81				Baghouses Down For Maintenance					
206.81				Baghouses Down For Maintenance					
207.81				Baghouses Down For Maintenance					
208.81	RA	0.00	0.00	0.17	0.23	1.00	120.00	0.17	0.23
209.81	RA	0.00	0.00	0.26	0.39	1.00	120.00	0.26	0.39
210.81	RA	0.00	0.00	0.44	0.81	2.00	120.00	0.22	0.41
211.81	RA	0.00	0.00	0.59	0.95	2.00	120.00	0.30	0.48
212.81	RA	3.80	12.00	0.56	0.83	2.00	120.00	0.28	0.42
Averages	RA	2.75	10.35					0.33	0.42

TABLE A-4 (continued)

North Baghouse										
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Average kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Pressure Drop Ratio
182.81	RA	0.00	0.00	1.56	2.01	1.50	120.00	1.04	1.34	0.26
183.81	RA	0.00	0.00	1.61	2.05	1.50	120.00	1.07	1.37	0.27
184.81	RA	0.00	0.00	1.64	2.10	1.50	120.00	1.09	1.40	0.26
185.81	RA	0.00	0.00	1.64	2.11	1.50	120.00	1.09	1.41	0.26
186.81	RA	0.00	0.00	1.63	2.09	1.50	120.00	1.09	1.39	0.27
187.81	RA	0.00	0.00	0.88	1.08	1.00	120.00	0.88	1.08	0.19
188.81	RA	0.00	0.00	0.79	1.13	1.00	120.00	0.79	1.13	0.27
189.81	RA	0.00	0.00	0.58	0.95	1.50	120.00	0.39	0.63	0.36
190.81	RA	0.00	0.00	0.86	1.28	2.00	120.00	0.43	0.64	0.48
191.81	RA	0.00	0.00	0.84	1.19	1.50	120.00	0.56	0.79	0.40
192.81	RA	0.00	0.00	0.90	1.26	1.50	120.00	0.60	0.84	0.38
193.81	RA	0.00	0.00	0.94	1.25	1.50	120.00	0.63	0.83	0.34
194.81	RA	0.00	0.00	0.96	1.30	1.50	120.00	0.64	0.87	0.38
195.81	RA	0.00	0.00	1.05	1.28	1.50	120.00	0.70	0.85	0.34
196.81	RA	0.00	0.00	1.19	1.38	1.50	120.00	0.79	0.92	0.34
197.81	Baghouses Down For Maintenance									---------
198.81	Baghouses Down For Maintenance									---------
199.81	Baghouses Down For Maintenance									---------
200.81	Baghouses Down For Maintenance									---------
201.81	Baghouses Down For Maintenance									---------
202.81	Baghouses Down For Maintenance									---------
203.81	Baghouses Down For Maintenance									---------
204.81	Baghouses Down For Maintenance									---------
205.81	Baghouses Down For Maintenance									---------
206.81	Baghouses Down For Maintenance									---------
207.81	Baghouses Down For Maintenance									---------
208.81	RA	0.00	0.00	0.23	0.35	1.00	120.00	0.23	0.35	1.00
209.81	RA	0.00	0.00	0.32	0.53	1.00	120.00	0.32	0.53	1.00
210.81	RA	0.00	0.00	0.55	1.08	2.00	120.00	0.28	0.54	0.80
211.81	RA	0.00	0.00	0.79	1.43	2.00	120.00	0.40	0.72	0.75
212.81	RA	0.00	0.00	1.00	1.56	2.00	120.00	0.50	0.78	0.54
Averages	RA	0.00	0.00					0.68	0.92	0.44

TABLE A-5. DATA SUMMARY FOR AUGUST 1981

					South	Baghouse			
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Average kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm
213.81	RA	3.80	10.00	0.56	0.83	2.00	120.00	0.28	0.42
214.81	RA	3.80	10.00	0.56	0.78	2.00	120.00	0.28	0.39
215.81	RA	1.90	6.00	0.59	0.88	2.00	120.00	0.30	0.44
216.81	RA	1.80	10.00	0.50	0.76	2.00	120.00	0.25	0.38
217.81	RA	1.60	30.00	0.49	0.73	2.00	120.00	0.25	0.37
218.81	RA	1.80	7.00	0.58	0.94	2.00	120.00	0.29	0.47
219.81	RA	3.20	20.00	0.49	0.74	2.00	120.00	0.25	0.37
220.81	RA	3.20	20.00	0.50	0.73	2.00	120.00	0.25	0.37
221.81	RA	3.20	18.00	0.50	0.71	2.00	120.00	0.25	0.36
222.81	RA	3.10	15.00	0.49	0.69	2.00	120.00	0.25	0.35
223.81	RA	6.00	10.00	0.49	0.71	2.00	120.00	0.25	0.36
224.81	RA	6.00	10.00	0.54	0.73	2.00	120.00	0.27	0.37
225.81	RA	2.70	55.00	0.74	1.00	2.00	120.00	0.37	0.50
226.81	RA	0.00	0.00	0.66	1.04	2.00	120.00	0.33	0.52
227.81	RA	0.00	0.00	0.65	0.91	2.00	120.00	0.33	0.46
228.81	RA	0.00	0.00	0.71	1.03	2.00	120.00	0.36	0.52
229.81	RA	6.00	10.00	0.66	0.86	2.00	120.00	0.33	0.43
230.81	RA	0.00	0.00	0.60	0.88	2.00	120.00	0.30	0.44
231.81	RA	0.00	0.00	0.80	1.13	2.00	120.00	0.40	0.57
232.81	RA	0.00	0.00	0.91	1.25	2.00	120.00	0.46	0.63
233.81	RA	6.10	5.00	0.78	0.99	2.00	120.00	0.39	0.50
234.81	RA	6.10	5.00	0.78	1.03	2.00	120.00	0.39	0.52
235.81	RA	6.10	5.00	0.83	1.09	2.00	120.00	0.42	0.55
236.81	RA	6.10	5.00	0.38	0.43	1.25	120.00	0.30	0.34
237.81	RA	6.10	5.00	0.38	0.43	1.25	120.00	0.30	0.34
238.81	RA	6.10	5.00	0.41	0.48	1.25	120.00	0.33	0.38
239.81	RA	3.90	5.00	0.41	0.50	1.25	120.00	0.33	0.40
240.81	RA	3.90	5.00	0.41	0.50	1.25	120.00	0.33	0.40
241.81	RA	3.90	5.00	0.39	0.48	1.25	120.00	0.31	0.38
242.81	RA	3.40	55.00	0.36	0.44	1.25	120.00	0.29	0.35
243.81	RA	1.60	45.00	0.35	0.44	1.25	120.00	0.28	0.35
Averages	RA	3.27	12.13					0.31	0.43

TABLE A-5 (continued)

North Baghouse										
Julian Date day.year	Status	Field kV/cm	Current microamos	Delta P Residual kPa	Delta P Average kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Pressure Drop Ratio
213.81	RA	0.00	0.00	1.04	1.63	2.00	120.00	0.52	0.82	0.55
214.81	RA	0.00	0.00	1.11	1.71	2.00	120.00	0.56	0.86	0.54
215.81	RA	0.00	0.00	1.14	1.70	2.00	120.00	0.57	0.85	0.60
216.81	RA	0.00	0.00	1.10	1.70	2.00	120.00	0.55	0.85	0.56
217.81	RA	0.00	0.00	1.14	1.70	2.00	120.00	0.57	0.85	0.55
218.81	RA	0.00	0.00	1.19	1.75	2.00	120.00	0.60	0.88	0.68
219.81	RA	0.00	0.00	1.17	1.81	2.00	120.00	0.59	0.91	0.49
220.81	RA	0.00	0.00	1.18	1.83	2.00	120.00	0.59	0.92	0.49
221.81	RA	0.00	0.00	1.17	1.81	2.00	120.00	0.59	0.91	0.47
222.81	RA	0.00	0.00	1.23	1.89	2.00	120.00	0.62	0.95	0.48
223.81	RA	0.00	0.00	1.14	1.78	2.00	120.00	0.57	0.89	0.42
224.81	RA	0.00	0.00	1.21	1.73	2.00	120.00	0.61	0.87	0.45
225.81	RA	0.00	0.00	1.45	2.13	2.00	120.00	0.73	1.07	0.58
226.81	RA	0.00	0.00	1.41	1.96	2.00	120.00	0.71	0.98	0.68
227.81	RA	0.00	0.00	1.31	1.84	2.00	120.00	0.66	0.92	0.64
228.81	RA	0.00	0.00	1.44	1.94	2.00	120.00	0.72	0.97	0.68
229.81	RA	0.00	0.00	1.40	1.99	2.00	120.00	0.70	1.00	0.39
230.81	RA	0.00	0.00	1.00	1.50	2.00	120.00	0.50	0.75	0.70
231.81	RA	0.00	0.00	1.24	1.93	2.00	120.00	0.62	0.97	0.80
232.81	RA	0.00	0.00	1.33	1.90	2.00	120.00	0.67	0.95	0.80
233.81	RA	0.00	0.00	1.28	1.84	2.00	120.00	0.64	0.92	0.55
234.81	RA	0.00	0.00	1.34	1.93	2.00	120.00	0.67	0.97	0.53
235.81	RA	0.00	0.00	1.39	1.98	2.00	120.00	0.70	0.99	0.61
236.81	RA	0.00	0.00	0.73	1.08	1.25	120.00	0.58	0.86	0.32
237.81	RA	0.00	0.00	0.80	1.13	1.25	120.00	0.64	0.90	0.33
238.81	RA	0.00	0.00	0.84	1.25	1.25	120.00	0.67	1.00	0.30
239.81	RA	0.00	0.00	0.84	1.19	1.25	120.00	0.67	0.95	0.34
240.81	RA	0.00	0.00	0.84	1.18	1.25	120.00	0.67	0.94	0.31
241.81	RA	0.00	0.00	0.85	1.18	1.25	120.00	0.68	0.94	0.30
242.81	RA	0.00	0.00	0.84	1.15	1.25	120.00	0.67	0.92	0.25
243.81	RA	0.00	0.00	0.84	1.13	1.25	120.00	0.67	0.90	0.33
Averages	RA	0.00	0.00					0.63	0.92	0.51

TABLE A-6. DATA SUMMARY FOR SEPTEMBER 1981

					South Baghouse				
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Average kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm
244.81	RA	Data Not Available							
245.81	RA	Data Not Available							
246.81	RA	0.00	0.00	0.44	0.54	1.25	120.00	0.35	0.43
247.81	RA	0.00	0.00	0.43	0.48	1.25	120.00	0.34	0.38
248.81	RA	0.00	0.00	0.43	0.48	1.25	120.00	0.34	0.38
249.81	RA	0.00	0.00	0.44	0.50	1.25	120.00	0.35	0.40
250.81	RA	0.00	0.00	0.44	0.55	1.25	120.00	0.35	0.44
251.81	RA	3.20	50.00	0.41	0.45	1.25	120.00	0.33	0.36
252.81	RA	3.20	50.00	0.39	0.44	1.25	120.00	0.31	0.35
253.81	RA	3.20	50.00	0.38	0.45	1.25	120.00	0.30	0.36
254.81	RA	Baghouses Down For Maintenance							
255.81	RA	Baghouses Down For Maintenance							
256.81	RA	Baghouses Down For Maintenance							
257.81	RA	Baghouses Down For Maintenance							
258.81	RA	Baghouses Down For Maintenance							
259.81	RA	Baghouses Down For Maintenance							
260.81	RA	3.80	20.00	0.23	0.30	1.25	120.00	0.18	0.24
261.81	RA	3.70	10.00	0.33	0.38	1.25	120.00	0.26	0.30
262.81	RA	3.70	10.00	0.34	0.38	1.25	120.00	0.27	0.30
263.81	RA	3.70	10.00	0.34	0.38	1.25	120.00	0.27	0.30
264.81	RA	Cleaning Timer Failed--No Data							
265.81	RA	4.30	70.00	1.10	1.62	2.00	150.00	0.55	0.81
266.81	RA	4.30	100.00	1.43	1.83	2.00	168.00	0.72	0.92
267.81	RA	2.00	350.00	0.87	1.22	2.00	150.00	0.44	0.61
268.81	RA	0.00	0.00	0.87	1.22	2.00	150.00	0.44	0.61
269.81	RA	0.00	0.00	0.82	1.21	2.00	150.00	0.41	0.61
270.81	RA	0.00	0.00	0.87	1.23	2.00	150.00	0.44	0.62
271.81	RA	Data Not Available							
272.81	RA	Data Not Available							
273.81	RA	Data Not Available							
Averages	RA	1.95	40.00					0.37	0.47

TABLE A-6 (continued)

				North Baghouse						
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Average kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Pressure Drop Ratio
244.81					Data Not Available					---------
245.81					Data Not Available					---------
246.81	RA	0.00	0.00	0.92	1.29	1.25	120.00	0.74	1.03	0.48
247.81	RA	0.00	0.00	0.88	1.15	1.25	120.00	0.70	0.92	0.40
248.81	RA	0.00	0.00	0.91	1.16	1.25	120.00	0.73	0.93	0.44
249.81	RA	0.00	0.00	0.90	1.16	1.25	120.00	0.72	0.93	0.42
250.81	RA	0.00	0.00	0.94	1.18	1.25	120.00	0.75	0.94	0.50
251.81	RA	0.00	0.00	0.91	1.19	1.25	120.00	0.73	0.95	0.31
252.81	RA	0.00	0.00	0.88	1.18	1.25	120.00	0.70	0.94	0.20
253.81	RA	0.00	0.00	0.89	1.16	1.25	120.00	0.71	0.93	0.19
254.81				Baghouses Down For Maintenance						---------
255.81				Baghouses Down For Maintenance						---------
256.81				Baghouses Down For Maintenance						---------
257.81				Baghouses Down For Maintenance						---------
258.81				Baghouses Down For Maintenance						---------
259.81				Baghouses Down For Maintenance						---------
260.81	RA	0.00	0.00	0.36	0.58	1.25	120.00	0.29	0.46	0.31
261.81	RA	0.00	0.00	0.52	0.80	1.25	120.00	0.42	0.64	0.24
262.81	RA	0.00	0.00	0.55	0.80	1.25	120.00	0.44	0.64	0.22
263.81	RA	0.00	0.00	0.56	0.80	1.25	120.00	0.45	0.64	0.21
264.81				Cleaning Timer Failed--No Data						---------
265.81	RA	0.00	0.00	0.35	0.73	1.40	150.00	0.25	0.52	1.00
266.81	RA	0.00	0.00	0.62	0.98	1.40	90.00	0.44	0.70	0.84
267.81	RA	0.00	0.00	0.75	1.11	1.40	150.00	0.54	0.79	0.70
268.81	RA	0.00	0.00	0.70	1.08	1.30	150.00	0.54	0.83	0.67
269.81	RA	0.00	0.00	0.67	1.03	1.30	150.00	0.52	0.79	0.73
270.81	RA	0.00	0.00	0.75	1.06	1.30	150.00	0.58	0.82	0.83
271.81					Data Not Available					---------
272.81					Data Not Available					---------
273.81					Data Not Available					---------
Averages	RA	0.00	0.00					0.57	0.80	0.48

TABLE A-7. DATA SUMMARY FOR OCTOBER 1981

				South	Baghouse						
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrold kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
274.81	RA	4.00	100.00	1.47	1.66	2.00	3.00	60.00	0.49	0.61	0.67
275.81	RA	2.00	75.00	1.56	1.77	2.00	3.00	45.00	0.52	0.63	0.67
276.81	RA	Bags Blinded -- No Useful Data									
277.81	RA	Bags Blinded -- No Useful Data									
278.81	RA	2.00	20.00	1.75	1.97	2.31	3.00	72.00	0.58	0.71	0.77
279.81	RA	2.00	20.00	1.75	2.00	2.35	3.00	72.00	0.58	0.73	0.78
280.81	RA	2.00	100.00	1.97	2.16	2.42	3.00	72.00	0.66	0.76	0.81
281.81	RA	6.00	50.00	0.12	0.15	0.39	2.00	180.00	0.06	0.14	0.20
282.81	RA	6.00	50.00	0.17	0.20	0.47	2.00	180.00	0.09	0.17	0.24
283.81	RA	6.00	30.00	0.19	0.26	0.52	2.00	180.00	0.10	0.20	0.26
284.81	RA	6.00	30.00	0.20	0.32	0.62	2.00	180.00	0.10	0.24	0.31
285.81	RA	6.00	50.00	0.31	0.45	0.75	2.00	180.00	0.16	0.30	0.38
286.81	RA	6.00	70.00	0.41	0.42	0.75	1.50	120.00	0.27	0.39	0.50
287.81	RA	6.00	30.00	0.33	0.34	0.52	1.50	120.00	0.22	0.29	0.35
288.81	RA	2.00	20.00	0.34	0.35	0.55	1.50	120.00	0.23	0.30	0.37
289.81	RA	0.00	0.00	0.39	0.41	0.69	1.50	120.00	0.26	0.37	0.46
290.81	RA	6.00	20.00	0.38	0.39	0.57	1.50	120.00	0.25	0.32	0.38
291.81	RA	6.00	50.00	0.38	0.40	0.54	1.50	120.00	0.25	0.31	0.36
292.81	RA	6.00	150.00	0.37	0.38	0.53	1.50	120.00	0.25	0.30	0.35
293.81	RA	0.00	0.00	0.49	0.53	0.80	1.50	120.00	0.33	0.44	0.53
294.81	RA	0.00	0.00	0.52	0.59	0.81	1.50	120.00	0.35	0.47	0.54
295.81	RA	0.00	0.00	0.31	0.35	0.55	1.50	120.00	0.21	0.30	0.37
296.81	RA	0.00	0.00	0.37	0.42	0.65	1.50	120.00	0.25	0.36	0.43
297.81	RA	0.00	0.00	0.44	0.51	0.74	1.50	120.00	0.29	0.42	0.49
298.81	RA	0.00	0.00	0.48	0.54	0.80	1.50	120.00	0.32	0.45	0.53
299.81	RA	0.00	0.00	0.47	0.51	0.76	1.50	120.00	0.31	0.42	0.51
300.81	RA	Data Not Available									
301.81	RA	Data Not Available									
302.81	RA	Data Not Available									
303.81	RA	Data Not Available									
304.81	RA	Data Not Available									
Averages	RA	3.08	36.04	0.63	0.71	0.96	1.92	120.88	0.30	0.40	0.47

TABLE A-7 (continued)

						North Baghouse					
Julian Date day.year	Current Status	Delta P Field kV/cm	Delta P Current microamps	Delta P Residual kPa	Delta P Extroltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
274.81	RA	0.00	0.00	0.75	0.88	1.06	1.30	60.00	0.58	0.75	0.82
275.81	RA	0.00	0.00	0.81	0.93	1.07	1.30	45.00	0.62	0.77	0.82
276.81	Bags Blinded -- No Useful Data										
277.81	Bags Blinded -- No Useful Data										
278.81	RA	0.00	0.00	0.93	1.12	1.36	1.25	72.00	0.74	0.99	1.09
279.81	RA	0.00	0.00	1.00	1.12	1.35	1.25	72.00	0.80	0.99	1.08
280.81	RA	0.00	0.00	0.93	1.36	1.52	1.25	72.00	0.74	1.15	1.22
281.81	RA	0.00	0.00	1.62	2.07	2.55	2.00	180.00	0.81	1.16	1.28
282.81	RA	0.00	0.00	1.56	1.96	2.47	2.00	180.00	0.78	1.11	1.24
283.81	RA	0.00	0.00	1.56	1.94	2.44	2.00	180.00	0.78	1.10	1.22
284.81	RA	0.00	0.00	1.56	1.97	2.55	2.00	180.00	0.78	1.13	1.28
285.81	RA	0.00	0.00	1.81	2.19	2.62	2.00	180.00	0.91	1.20	1.31
286.81	RA	0.00	0.00	1.73	2.12	2.61	1.50	120.00	1.15	1.58	1.74
287.81	RA	0.00	0.00	1.20	1.42	1.79	1.50	120.00	0.80	1.07	1.19
288.81	RA	0.00	0.00	1.20	1.39	1.71	1.50	120.00	0.80	1.03	1.14
289.81	RA	0.00	0.00	1.38	1.58	2.00	1.50	120.00	0.92	1.19	1.33
290.81	RA	0.00	0.00	1.32	1.54	1.89	1.50	120.00	0.88	1.14	1.26
291.81	RA	0.00	0.00	1.31	1.54	1.83	1.50	120.00	0.87	1.12	1.22
292.81	RA	0.00	0.00	1.31	1.49	1.79	1.50	120.00	0.87	1.09	1.19
293.81	RA	0.00	0.00	1.33	1.55	1.86	1.50	120.00	0.89	1.14	1.24
294.81	RA	0.00	0.00	1.37	1.60	1.87	1.50	120.00	0.91	1.16	1.25
295.81	RA	0.00	0.00	1.32	1.51	1.78	1.50	120.00	0.88	1.10	1.19
296.81	RA	0.00	0.00	1.31	1.53	1.82	1.50	120.00	0.87	1.12	1.21
297.81	RA	0.00	0.00	1.55	1.59	1.87	1.50	120.00	0.90	1.15	1.25
298.81	RA	0.00	0.00	1.38	1.60	1.91	1.50	120.00	0.92	1.17	1.27
299.81	RA	0.00	0.00	1.38	1.56	1.86	1.50	120.00	0.92	1.14	1.24
300.81	Data Not Available										
301.81	Data Not Available										
302.81	Data Not Available										
303.81	Data Not Available										
304.81	Data Not Available										
Averages	RA	0.00	0.00	1.31	1.57	1.90	1.56	120.88	0.84	1.11	1.21

TABLE A-8. DATA SUMMARY FOR NOVEMBER 1981

South Baghouse											
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpld kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
305.81	RA	0.00	0.00	0.19	0.26	0.47	1.50	120.00	0.13	0.24	0.31
306.81	RA	0.00	0.00	0.37	0.47	0.66	1.50	120.00	0.25	0.38	0.44
307.81	RA	0.00	0.00	0.35	0.44	0.65	1.50	120.00	0.23	0.36	0.43
308.81	RA	0.00	0.00	0.37	0.45	0.65	1.50	120.00	0.25	0.37	0.43
309.81	RA	0.00	0.00	0.44	0.55	0.85	1.50	120.00	0.29	0.47	0.57
310.81	RA	0.00	0.00	0.45	0.49	0.72	1.50	120.00	0.30	0.40	0.48
311.81	RA	Data Not Available									
312.81	RA	Data Not Available									
313.81	RA	0.00	0.00	0.39	0.52	0.72	1.50	120.00	0.26	0.41	0.48
314.81	RA	0.00	0.00	0.37	0.47	0.72	1.50	120.00	0.25	0.40	0.48
315.81	RA	0.00	0.00	0.25	0.39	0.60	1.50	120.00	0.17	0.33	0.40
316.81	RA	0.00	0.00	0.31	0.45	0.62	1.50	120.00	0.21	0.36	0.41
317.81	RA	0.00	0.00	0.35	0.50	0.72	1.50	120.00	0.23	0.41	0.48
318.81	RA	0.00	0.00	0.37	0.51	0.71	1.50	120.00	0.25	0.41	0.47
319.81	RA	0.00	0.00	0.36	0.55	0.72	1.50	120.00	0.24	0.42	0.48
320.81	RA	0.00	0.00	0.34	0.45	0.62	1.50	120.00	0.23	0.36	0.41
321.81	RA	0.00	0.00	0.51	0.74	1.05	1.50	120.00	0.34	0.60	0.70
322.81	RA	0.00	0.00	1.05	1.21	1.88	2.25	120.00	0.47	0.69	0.84
323.81	RA	0.00	0.00	0.61	0.74	1.20	2.00	120.00	0.31	0.49	0.60
324.81	RA	0.00	0.00	0.26	0.32	0.49	1.00	120.00	0.26	0.41	0.49
325.81	RA	0.00	0.00	0.31	0.37	0.51	1.00	120.00	0.31	0.44	0.51
326.81	RA	0.00	0.00	0.32	0.36	0.50	1.00	120.00	0.32	0.43	0.50
327.81	RA	Start-Up With New Bags									
328.81	RA	0.00	0.00	0.37	0.56	0.78	2.00	120.00	0.19	0.34	0.39
329.81	RA	0.00	0.00	0.20	0.25	0.31	1.00	120.00	0.20	0.28	0.31
330.81	RA	0.00	0.00	0.20	0.24	0.30	1.00	120.00	0.20	0.27	0.30
331.81	RA	Data Not Available									
332.81	RA	Data Not Available									
333.81	RA	Data Not Available									
334.81	RA	Data Not Available									
Averages	RA	0.00	0.00	0.38	0.49	0.72	1.47	120.00	0.25	0.40	0.47

TABLE A-8 (continued)

North Baghouse

Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
305.81	RA	0.00	0.00	0.35	0.47	0.75	1.50	120.00	0.23	0.41	0.50
306.81	RA	0.00	0.00	0.51	0.62	0.85	1.50	120.00	0.34	0.49	0.57
307.81	RA	0.00	0.00	0.50	0.60	0.85	1.50	120.00	0.33	0.48	0.57
308.81	RA	0.00	0.00	0.44	0.59	0.82	1.50	120.00	0.29	0.47	0.55
309.81	RA	0.00	0.00	0.59	0.70	1.05	1.50	120.00	0.39	0.58	0.70
310.81	RA	0.00	0.00	0.50	0.61	0.90	1.50	120.00	0.33	0.50	0.60
311.81					Data Not Available						
312.81					Data Not Available						
313.81	RA	0.00	0.00	0.64	0.71	0.95	1.50	120.00	0.43	0.55	0.63
314.81	RA	0.00	0.00	0.44	0.62	0.95	1.50	120.00	0.29	0.52	0.63
315.81	RA	0.00	0.00	0.25	0.44	0.67	1.50	120.00	0.17	0.37	0.45
316.81	RA	0.00	0.00	0.26	0.50	0.70	1.50	120.00	0.17	0.40	0.47
317.81	RA	0.00	0.00	0.35	0.56	0.80	1.50	120.00	0.23	0.45	0.53
318.81	RA	0.00	0.00	0.37	0.59	0.83	1.50	120.00	0.25	0.47	0.55
319.81	RA	0.00	0.00	0.41	0.64	0.85	1.50	120.00	0.27	0.50	0.57
320.81	RA	0.00	0.00	0.36	0.49	0.69	1.50	120.00	0.24	0.39	0.46
321.81	RA	0.00	0.00	0.50	0.74	1.02	1.50	120.00	0.33	0.59	0.68
322.81	RA	0.00	0.00	0.82	1.23	1.93	2.25	120.00	0.36	0.70	0.86
323.81	RA	0.00	0.00	0.56	0.85	1.21	2.00	120.00	0.28	0.52	0.61
324.81	RA	0.00	0.00	0.27	0.37	0.56	1.00	120.00	0.27	0.47	0.56
325.81	RA	0.00	0.00	0.31	0.41	0.60	1.00	120.00	0.31	0.51	0.60
326.81	RA	0.00	0.00	0.31	0.36	0.56	1.00	120.00	0.31	0.46	0.56
327.81					Start-Up With New Bags						
328.81	RA	0.00	0.00	0.61	0.75	1.21	2.00	120.00	0.31	0.49	0.61
329.81	RA	0.00	0.00	0.30	0.39	0.50	1.00	120.00	0.30	0.45	0.50
330.81	RA	0.00	0.00	0.31	0.36	0.52	1.00	120.00	0.31	0.44	0.52
331.81					Data Not Available						
332.81					Data Not Available						
333.81					Data Not Available						
334.81					Data Not Available						
Averages	RA	0.00	0.00	0.43	0.59	0.86	1.47	120.00	0.29	0.49	0.58

TABLE A-9. DATA SUMMARY FOR DECEMBER 1981

					South Baghouse						
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpld kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
335.81	RA	4.00	Not Avl.	0.62	0.91	1.22	2.00	120.00	0.31	0.53	0.61
336.81	RA	4.90	Not Avl.	0.69	1.00	1.37	2.40	120.00	0.29	0.49	0.57
337.81	RA	4.90	Not Avl.	0.69	1.03	1.37	2.40	120.00	0.29	0.50	0.57
338.81	RA	4.90	Not Avl.	0.75	1.07	1.43	2.00	120.00	0.38	0.63	0.72
339.81	RA	4.90	Not Avl.	0.87	1.31	1.77	2.00	120.00	0.44	0.77	0.89
340.81	RA	4.90	Not Avl.	1.02	1.28	1.76	2.00	120.00	0.51	0.76	0.88
341.81	RA	6.00	Not Avl.	0.87	1.40	1.76	2.00	120.00	0.44	0.79	0.88
342.81	RA	6.00	Not Avl.	0.93	1.45	1.83	2.00	120.00	0.47	0.82	0.92
343.81	RA	6.00	Not Avl.	1.18	1.59	2.00	2.00	120.00	0.59	0.90	1.00
344.81	RA	Compressor Down - No Cleaning									
345.81	RA	6.00	Not Avl.	0.59	0.77	0.95	1.50	120.00	0.39	0.57	0.63
346.81	RA	Compressor Down - No Cleaning									
347.81	RA	Compressor Down - No Cleaning									
348.81	RA	Compressor Down - No Cleaning									
349.81	RA	Compressor Down - No Cleaning									
350.81	RA	6.00	Not Avl.	0.50	0.93	1.35	1.50	240.00	0.33	0.76	0.90
351.81	RA	6.00	Not Avl.	0.69	1.12	1.53	1.50	240.00	0.46	0.88	1.02
352.81	RA	6.00	Not Avl.	0.57	1.12	1.57	1.50	240.00	0.38	0.90	1.05
353.81	RA	Data Not Available									
354.81	RA	Data Not Available									
355.81	RA	0.00	0.00	0.62	1.02	1.57	1.50	240.00	0.41	0.86	1.05
356.81	RA	0.00	0.00	0.56	1.08	1.58	1.50	240.00	0.37	0.89	1.05
357.81	RA	4.00	Not Avl.	0.58	0.84	1.38	1.50	240.00	0.39	0.74	0.92
358.81	RA	4.00	Not Avl.	0.56	0.82	1.28	1.50	240.00	0.37	0.70	0.85
359.81	RA	4.00	Not Avl.	0.58	0.84	1.40	1.50	240.00	0.39	0.75	0.93
360.81	RA	4.00	Not Avl.	0.62	0.85	1.38	1.50	240.00	0.41	0.74	0.92
361.81	RA	4.00	Not Avl.	0.62	0.86	1.36	1.50	240.00	0.41	0.74	0.91
362.81	RA	4.00	Not Avl.	0.82	1.24	1.92	2.00	240.00	0.41	0.79	0.96
363.81	RA	4.00	Not Avl.	0.89	1.29	2.06	2.00	240.00	0.45	0.84	1.03
364.81	RA	4.00	Not Avl.	1.01	1.44	2.16	2.00	240.00	0.51	0.90	1.08
365.81	RA	Data Not Available									
Averages	RA	4.46	0.00	0.73	1.10	1.57	1.80	187.83	0.41	0.75	0.88

TABLE A-9 (continued)

North Baghouse											
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
335.81	RA	0.00	0.00	0.87	1.20	1.61	2.00	120.00	0.44	0.70	0.81
336.81	RA	0.00	0.00	1.01	1.43	1.91	2.00	120.00	0.51	0.84	0.96
337.81	RA	0.00	0.00	1.00	1.47	1.91	2.00	120.00	0.50	0.85	0.96
338.81	RA	0.00	0.00	1.00	1.42	1.89	2.00	120.00	0.50	0.83	0.95
339.81	RA	0.00	0.00	1.31	1.87	2.32	2.00	120.00	0.66	1.05	1.16
340.81	RA	0.00	0.00	1.31	1.87	2.34	2.00	120.00	0.66	1.05	1.17
341.81	RA	0.00	0.00	1.50	2.09	2.45	2.00	120.00	0.75	1.14	1.23
342.81	RA	0.00	0.00	1.48	2.11	2.47	2.00	120.00	0.74	1.15	1.24
343.81	RA	0.00	0.00	1.50	2.08	2.45	2.00	120.00	0.75	1.13	1.23
344.81	Compressor Down - No Cleaning										
345.81	RA	0.00	0.00	0.78	1.20	1.45	1.50	120.00	0.52	0.88	0.97
346.81	Compressor Down - No Cleaning										
347.81	Compressor Down - No Cleaning										
348.81	Compressor Down - No Cleaning										
349.81	Compressor Down - No Cleaning										
350.81	RA	0.00	0.00	0.40	0.85	1.35	1.50	240.00	0.27	0.73	0.90
351.81	RA	0.00	0.00	0.46	1.00	1.45	1.50	240.00	0.31	0.82	0.97
352.81	RA	0.00	0.00	0.44	0.90	1.40	1.50	240.00	0.29	0.77	0.93
353.81	Data Not Available										
354.81	Data Not Available										
355.81	RA	0.00	0.00	0.50	0.98	1.56	1.50	240.00	0.33	0.85	1.04
356.81	RA	0.00	0.00	0.50	0.97	1.56	1.50	240.00	0.33	0.84	1.04
357.81	RA	0.00	0.00	0.58	0.96	1.67	1.50	240.00	0.39	0.88	1.11
358.81	RA	0.00	0.00	0.55	0.91	1.57	1.50	240.00	0.37	0.83	1.05
359.81	RA	0.00	0.00	0.58	0.97	1.69	1.50	240.00	0.39	0.89	1.13
360.81	RA	0.00	0.00	0.63	1.01	1.70	1.50	240.00	0.42	0.90	1.13
361.81	RA	0.00	0.00	0.64	1.01	1.66	1.50	240.00	0.43	0.89	1.11
362.81	RA	0.00	0.00	0.18	0.26	0.45	0.75	240.00	0.24	0.47	0.60
363.81	RA	0.00	0.00	0.22	0.33	0.52	0.75	240.00	0.29	0.57	0.69
364.81	RA	0.00	0.00	0.23	0.31	0.53	0.75	240.00	0.31	0.56	0.71
365.81	Data Not Available										
Averages	RA	0.00	0.00	0.77	1.18	1.65	1.60	187.83	0.45	0.85	1.00

TABLE A-10. DATA SUMMARY FOR JANUARY 1982

South Baghouse

Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrold kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
1.82	Cleaning System Failure--No Data										
2.82	Cleaning System Failure--No Data										
3.82	Cleaning System Failure--No Data										
4.82	RA	4.00	Not Avl.	0.83	1.19	1.88	2.00	240.00	0.42	0.77	0.94
5.82	RA	4.00	Not Avl.	0.91	1.36	2.06	2.00	240.00	0.46	0.86	1.03
6.82	RA	4.00	Not Avl.	0.86	1.23	1.87	2.00	240.00	0.43	0.78	0.94
7.82	RA	4.00	Not Avl.	0.99	1.80	2.34	2.00	240.00	0.50	1.04	1.17
8.82	RA	4.00	Not Avl.	0.86	1.22	1.80	2.00	240.00	0.43	0.76	0.90
9.82	RA	4.00	Not Avl.	0.99	1.36	2.02	2.00	240.00	0.50	0.85	1.01
10.82	Data Not Available										
11.82	RA	4.00	Not Avl.	0.77	1.14	1.74	2.00	240.00	0.39	0.72	0.87
12.82	RA	4.00	Not Avl.	0.82	1.26	1.91	2.00	240.00	0.41	0.79	0.96
13.82	RA	4.00	Not Avl.	0.83	1.22	1.76	2.00	240.00	0.42	0.75	0.88
14.82	RA	4.00	Not Avl.	0.79	1.16	1.65	2.00	240.00	0.40	0.70	0.83
15.82	RA	4.00	Not Avl.	0.82	1.19	1.75	2.00	240.00	0.41	0.74	0.88
16.82	RA	4.00	Not Avl.	0.80	1.20	1.82	2.00	240.00	0.40	0.76	0.91
17.82	Data Not Available										
18.82	Data Not Available										
19.82	Data Not Available										
20.82	RA	4.00	Not Avl.	0.72	0.95	1.50	2.00	240.00	0.36	0.61	0.75
21.82	RA	4.00	Not Avl.	0.78	1.10	1.58	2.00	240.00	0.39	0.67	0.79
22.82	RA	4.00	Not Avl.	0.65	0.93	1.33	2.00	240.00	0.33	0.57	0.67
23.82	RA	4.00	Not Avl.	0.67	0.92	1.36	2.00	240.00	0.34	0.57	0.68
24.82	RA	4.00	Not Avl.	0.80	1.13	1.62	2.00	240.00	0.40	0.69	0.81
25.82	RA	4.00	Not Avl.	0.94	1.22	1.76	2.00	240.00	0.47	0.75	0.88
26.82	RA	4.00	Not Avl.	0.89	1.20	1.73	2.00	240.00	0.45	0.73	0.87
27.82	RA	4.00	Not Avl.	0.93	1.29	1.76	2.00	240.00	0.47	0.76	0.88
28.82	RA	4.00	Not Avl.	0.88	1.21	1.71	2.00	240.00	0.44	0.73	0.86
29.82	RA	4.00	Not Avl.	1.11	1.41	1.87	2.00	240.00	0.56	0.82	0.94
30.82	RA	4.00	Not Avl.	1.02	1.30	1.73	2.00	240.00	0.51	0.76	0.87
31.82	RA	4.00	Not Avl.	0.99	1.28	1.71	2.00	240.00	0.50	0.75	0.86
Averages	RA	4.00	Not Avl.	0.86	1.22	1.76	2.00	240.00	0.43	0.75	0.88

TABLE A-10 (continued)

North Baghouse											
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
1.82	Cleaning System Failure--No Data										
2.82	Cleaning System Failure--No Data										
3.82	Cleaning System Failure--No Data										
4.82	RA	0.00	0.00	0.19	0.22	0.40	0.75	240.00	0.25	0.41	0.53
5.82	RA	0.00	0.00	0.08	0.08	0.16	0.75	240.00	0.11	0.16	0.21
6.82	RA	0.00	0.00	0.26	0.32	0.52	0.75	240.00	0.35	0.56	0.69
7.82	RA	0.00	0.00	0.23	0.30	0.51	0.75	240.00	0.31	0.54	0.68
8.82	RA	0.00	0.00	0.22	0.29	0.46	0.75	240.00	0.29	0.50	0.61
9.82	RA	0.00	0.00	0.28	0.36	0.54	0.75	240.00	0.37	0.60	0.72
10.82	Data Not Available										
11.82	RA	0.00	0.00	0.28	0.35	0.55	0.75	240.00	0.37	0.60	0.73
12.82	RA	0.00	0.00	0.39	0.56	0.77	0.75	240.00	0.52	0.89	1.03
13.82	RA	0.00	0.00	0.38	0.57	0.75	0.75	240.00	0.51	0.88	1.00
14.82	RA	0.00	0.00	0.37	0.50	0.70	0.75	240.00	0.49	0.80	0.93
15.82	RA	0.00	0.00	0.34	0.47	0.68	0.75	240.00	0.45	0.77	0.91
16.82	RA	0.00	0.00	0.34	0.48	0.70	0.75	240.00	0.45	0.79	0.93
17.82	Data Not Available										
18.82	Data Not Available										
19.82	Data Not Available										
20.82	RA	0.00	0.00	0.39	0.53	0.67	0.75	240.00	0.52	0.80	0.89
21.82	RA	0.00	0.00	0.41	0.63	0.72	0.75	240.00	0.55	0.90	0.96
22.82	RA	0.00	0.00	0.93	1.26	1.66	1.50	240.00	0.62	0.97	1.11
23.82	RA	0.00	0.00	0.93	1.29	1.72	1.50	240.00	0.62	1.00	1.15
24.82	RA	0.00	0.00	1.00	1.41	1.84	1.50	240.00	0.67	1.08	1.23
25.82	RA	0.00	0.00	1.04	1.42	1.92	2.00	240.00	0.52	0.84	0.96
26.82	RA	0.00	0.00	1.08	1.52	2.04	2.00	240.00	0.54	0.89	1.02
27.82	RA	0.00	0.00	1.11	1.54	2.01	2.00	240.00	0.56	0.89	1.01
28.82	RA	0.00	0.00	1.11	1.56	2.06	2.00	240.00	0.56	0.91	1.03
29.82	RA	0.00	0.00	1.03	1.39	1.96	2.00	240.00	0.52	0.84	0.98
30.82	RA	0.00	0.00	1.03	1.45	1.95	2.00	240.00	0.52	0.85	0.98
31.82	RA	0.00	0.00	1.03	1.53	1.98	2.00	240.00	0.52	0.88	0.99
Averages	RA	0.00	0.00	0.60	0.83	1.14	1.21	240.00	0.47	0.76	0.89

TABLE A-11. DATA SUMMARY FOR FEBRUARY 1982

South Baghouse											
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpld kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
32.82	RA	4.00	Not Avl.	1.15	1.47	1.81	2.00	120.00	0.58	0.82	0.91
33.82	RA	4.00	Not Avl.	1.29	1.45	1.74	2.00	120.00	0.65	0.80	0.87
34.82	RA	4.00	Not Avl.	1.18	1.32	1.54	2.00	120.00	0.59	0.72	0.77
35.82	RA	4.00	Not Avl.	1.13	1.30	1.54	2.00	120.00	0.57	0.71	0.77
36.82	RA	4.00	Not Avl.	1.16	1.37	1.64	2.00	120.00	0.58	0.75	0.82
37.82	RA	4.00	Not Avl.	1.19	1.41	1.67	2.00	120.00	0.60	0.77	0.84
38.82	RA	4.00	Not Avl.	1.24	1.46	1.72	2.00	120.00	0.62	0.80	0.86
39.82	RA	4.00	Not Avl.	1.25	1.45	1.75	2.00	120.00	0.63	0.80	0.88
40.82	RA	4.00	Not Avl.	1.41	1.68	1.94	2.00	120.00	0.71	0.91	0.97
41.82	RA	4.00	Not Avl.	1.42	1.64	1.92	2.00	120.00	0.71	0.89	0.96
42.82	RA	4.00	Not Avl.	1.37	1.61	1.88	2.25	120.00	0.61	0.78	0.84
43.82	RA	4.00	Not Avl.	1.62	1.87	1.12	2.25	120.00	0.72	0.66	0.50
44.82	RA	4.00	Not Avl.	1.56	1.93	2.15	2.25	120.00	0.69	0.91	0.96
45.82	RA	4.00	Not Avl.	1.71	1.98	2.32	2.25	120.00	0.76	0.96	1.03
46.82	RA	4.00	Not Avl.	1.77	1.98	2.17	2.25	120.00	0.79	0.92	0.96
47.82	RA	4.00	Not Avl.	1.82	2.10	2.37	2.25	120.00	0.81	0.99	1.05
48.82	RA	0.00	0.00	1.05	1.32	1.63	2.00	120.00	0.53	0.74	0.82
49.82	RA	0.00	0.00	1.12	1.37	1.70	2.00	120.00	0.56	0.77	0.85
50.82	RA	0.00	0.00	1.41	1.56	1.82	2.00	120.00	0.71	0.85	0.91
51.82	RA	0.00	0.00	1.15	1.35	1.65	2.00	120.00	0.58	0.75	0.83
52.82	RA	0.00	0.00	1.40	1.71	1.98	2.00	120.00	0.70	0.92	0.99
53.82	RA	0.00	0.00	1.37	1.65	1.93	2.00	120.00	0.69	0.90	0.97
54.82	RA	4.00	Not Avl.	1.19	1.37	1.68	2.00	120.00	0.60	0.76	0.84
55.82	RA	4.00	Not Avl.	1.31	1.45	1.76	2.00	120.00	0.66	0.80	0.88
56.82	RA	0.00	0.00	1.47	1.73	2.02	2.00	120.00	0.74	0.94	1.01
57.82	RA	0.00	0.00	1.40	1.68	2.02	2.00	120.00	0.70	0.93	1.01
58.82	RA	0.00	0.00	1.46	1.66	2.00	2.00	120.00	0.73	0.92	1.00
59.82	RA	0.00	0.00	1.43	1.66	2.00	2.00	120.00	0.72	0.92	1.00
Averages	RA	2.57	0.00	1.36	1.59	1.84	2.05	120.00	0.66	0.83	0.90

TABLE A-11 (continued)

North Baghouse

Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
32.82	RA	0.00	0.00	1.21	1.70	2.10	2.00	120.00	0.61	0.95	1.05
33.82	RA	0.00	0.00	1.39	1.64	1.98	2.00	120.00	0.70	0.91	0.99
34.82	RA	0.00	0.00	1.35	1.59	1.90	2.00	120.00	0.68	0.87	0.95
35.82	RA	0.00	0.00	1.32	1.57	1.89	2.00	120.00	0.66	0.87	0.95
36.82	RA	0.00	0.00	1.34	1.64	1.93	2.00	120.00	0.67	0.89	0.97
37.82	RA	0.00	0.00	1.37	1.64	1.97	2.00	120.00	0.69	0.90	0.99
38.82	RA	0.00	0.00	1.39	1.72	2.02	2.00	120.00	0.70	0.94	1.01
39.82	RA	0.00	0.00	1.39	1.73	2.06	2.00	120.00	0.70	0.95	1.03
40.82	RA	0.00	0.00	1.38	1.66	1.92	2.00	120.00	0.69	0.90	0.96
41.82	RA	0.00	0.00	1.39	1.59	1.89	2.00	120.00	0.70	0.87	0.95
42.82	RA	0.00	0.00	1.35	1.60	1.90	2.25	120.00	0.60	0.78	0.84
43.82	RA	0.00	0.00	1.62	1.87	2.12	2.25	120.00	0.72	0.89	0.94
44.82	RA	0.00	0.00	1.37	1.71	2.02	2.25	120.00	0.61	0.83	0.90
45.82	RA	0.00	0.00	1.91	2.18	2.42	2.25	120.00	0.85	1.02	1.08
46.82	RA	Baghouse Down									
47.82	RA	Baghouse Down									
48.82	RA	0.00	0.00	0.94	1.16	1.46	2.00	120.00	0.47	0.66	0.73
49.82	RA	0.00	0.00	1.12	1.36	1.71	2.00	120.00	0.56	0.77	0.86
50.82	RA	0.00	0.00	1.37	1.71	2.00	2.00	120.00	0.69	0.93	1.00
51.82	RA	Baghouse Down									
52.82	RA	Baghouse Down									
53.82	RA	0.00	0.00	1.28	1.57	1.91	2.00	120.00	0.64	0.87	0.96
54.82	RA	0.00	0.00	1.37	1.70	2.05	2.00	120.00	0.69	0.94	1.03
55.82	RA	0.00	0.00	1.36	1.47	1.98	2.00	120.00	0.68	0.86	0.99
56.82	RA	0.00	0.00	1.47	1.77	2.15	2.00	120.00	0.74	0.98	1.08
57.82	RA	0.00	0.00	1.51	1.86	2.23	2.00	120.00	0.76	1.02	1.12
58.82	RA	0.00	0.00	1.50	1.85	2.23	2.00	120.00	0.75	1.02	1.12
59.82	RA	0.00	0.00	1.50	1.82	2.23	2.00	120.00	0.75	1.01	1.12
Averages	RA	0.00	0.00	1.38	1.67	2.00	2.04	120.00	0.68	0.90	0.98

TABLE A-12. DATA SUMMARY FOR MAY 1982

					South Baghouse						
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpld kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
121.82	RA	3.00	70.00	0.65	0.90	1.25	2.00	180.00	0.33	0.54	0.63
122.82	RA	3.00	70.00	0.60	0.84	1.20	2.00	180.00	0.30	0.51	0.60
123.82	RA	3.00	80.00	1.00	1.42	1.90	2.00	180.00	0.50	0.83	0.95
124.82	RA	3.00	80.00	1.05	1.57	2.05	2.00	180.00	0.53	0.91	1.03
125.82	RA	3.00	90.00	1.10	1.57	1.97	2.00	180.00	0.55	0.89	0.99
126.82	RA	3.00	90.00	1.10	1.45	1.95	2.00	180.00	0.55	0.85	0.98
127.82	RA	3.00	90.00	0.95	1.35	1.80	2.00	180.00	0.48	0.79	0.90
128.82	RA	3.00	100.00	1.00	1.25	2.00	2.00	180.00	0.50	0.81	1.00
129.82	RA	3.00	100.00	1.00	1.38	1.80	2.00	180.00	0.50	0.80	0.90
130.82	RA	3.00	100.00	1.00	1.40	1.80	2.00	180.00	0.50	0.80	0.90
131.82	RA	3.00	80.00	1.00	1.40	1.70	2.00	180.00	0.50	0.78	0.85
132.82	RA	3.00	80.00	1.30	1.95	2.22	2.00	180.00	0.65	1.04	1.11
133.82	RA	3.00	50.00	0.90	1.10	1.62	2.00	180.00	0.45	0.68	0.81
134.82	RA	3.00	50.00	1.15	1.45	1.80	2.00	180.00	0.58	0.81	0.90
135.82	RA	3.00	50.00	1.07	1.30	1.65	2.00	180.00	0.54	0.74	0.83
136.82	RA	3.00	50.00	1.05	1.32	1.70	2.00	180.00	0.53	0.76	0.85
137.82	RA	------------------Baghouses Down--Maintenance and New Bags------------------------------									
138.82	RA	------------------Baghouses Down--Maintenance and New Bags------------------------------									
139.82	RA	------------------Baghouses Down--Maintenance and New Bags------------------------------									
140.82	RA	------------------Baghouses Down--Maintenance and New Bags------------------------------									
141.82	RA	------------------Baghouses Down--Maintenance and New Bags------------------------------									
142.82	RA	------------------Baghouses Down--Maintenance and New Bags------------------------------									
143.82	RA	------------------Baghouses Down--Maintenance and New Bags------------------------------									
144.82	RA	3.00	20.00	0.07	0.15	0.25	1.00	180.00	0.07	0.20	0.25
145.82	RA	3.00	20.00	0.10	0.10	0.30	1.00	180.00	0.10	0.20	0.30
146.82	RA	3.00	500.00	0.35	0.60	1.25	2.00	180.00	0.18	0.46	0.63
147.82	RA	3.00	500.00	0.35	0.65	1.20	2.00	180.00	0.18	0.46	0.60
148.82	RA	3.00	75.00	0.15	0.17	0.27	1.00	180.00	0.15	0.22	0.27
149.82	RA	3.00	45.00	0.15	0.15	0.25	1.00	180.00	0.15	0.20	0.25
150.82	RA	3.00	30.00	0.10	0.12	0.22	1.00	180.00	0.10	0.17	0.22
151.82	RA	3.00	35.00	0.12	0.17	0.22	1.00	180.00	0.12	0.20	0.22
Averages	RA	3.00	102.29	0.72	0.99	1.35	1.75	180.00	0.38	0.61	0.71

TABLE A-12 (continued)

					North Baghouse						
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
121.82	RA	0.00	0.00	0.70	1.00	1.40	2.00	180.00	0.35	0.60	0.70
122.82	RA	0.00	0.00	0.70	0.97	1.35	2.00	180.00	0.35	0.58	0.68
123.82	RA	Valve Failure. No Cleaning									
124.82	RA	0.00	0.00	1.15	1.65	2.12	2.00	180.00	0.58	0.94	1.06
125.82	RA	0.00	0.00	1.30	1.70	2.20	2.00	180.00	0.65	0.98	1.10
126.82	RA	0.00	0.00	1.20	1.65	2.15	2.00	180.00	0.60	0.95	1.08
127.82	RA	0.00	0.00	1.20	1.75	2.20	2.00	180.00	0.60	0.99	1.10
128.82	RA	0.00	0.00	1.25	2.00	2.50	2.00	180.00	0.63	1.13	1.25
129.82	RA	0.00	0.00	1.25	2.00	2.50	2.00	180.00	0.63	1.13	1.25
130.82	RA	0.00	0.00	1.35	2.00	2.50	2.00	180.00	0.68	1.13	1.25
131.82	RA	0.00	0.00	1.25	2.00	2.50	2.00	180.00	0.63	1.13	1.25
132.82	RA	0.00	0.00	1.20	1.50	1.80	1.50	180.00	0.80	1.10	1.20
133.82	RA	0.00	0.00	0.65	0.85	1.20	1.50	180.00	0.43	0.68	0.80
134.82	RA	0.00	0.00	0.90	1.25	1.55	1.50	180.00	0.60	0.93	1.03
135.82	RA	0.00	0.00	0.85	1.17	1.47	1.50	180.00	0.57	0.88	0.98
136.82	RA	0.00	0.00	0.87	1.12	1.42	1.50	180.00	0.58	0.85	0.95
137.82	Baghouses Down--Maintenance and New Bags										
138.82	Baghouses Down--Maintenance and New Bags										
139.82	Baghouses Down--Maintenance and New Bags										
140.82	Baghouses Down--Maintenance and New Bags										
141.82	Baghouses Down--Maintenance and New Bags										
142.82	Baghouses Down--Maintenance and New Bags										
143.82	Baghouses Down--Maintenance and New Bags										
144.82	RA	3.00	15.00	0.07	0.15	0.25	1.00	180.00	0.07	0.20	0.25
145.82	RA	3.00	20.00	0.12	0.12	0.32	1.00	180.00	0.12	0.22	0.32
146.82	RA	3.00	500.00	0.45	0.80	1.45	2.00	180.00	0.23	0.56	0.73
147.82	RA	3.00	500.00	0.45	0.85	1.45	2.00	180.00	0.23	0.58	0.73
148.82	RA	3.00	75.00	0.17	0.22	0.37	1.00	180.00	0.17	0.30	0.37
149.82	RA	3.00	45.00	0.17	0.20	0.30	1.00	180.00	0.17	0.25	0.30
150.82	RA	3.00	30.00	0.15	0.20	0.30	1.00	180.00	0.15	0.25	0.30
151.82	RA	3.00	35.00	0.17	0.22	0.32	1.00	180.00	0.17	0.27	0.32
Averages	RA	1.04	53.04	0.76	1.10	1.46	1.63	180.00	0.43	0.72	0.83

TABLE A-13. DATA SUMMARY FOR JUNE 1982

					South Baghouse						
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrold kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
152.82	RA	0.00	0.00	0.25	0.35	0.45	1.00	180.00	0.25	0.40	0.45
153.82	RA	3.00	50.00	0.35	0.63	0.93	2.00	180.00	0.18	0.39	0.47
154.82	RA	3.00	500.00	0.40	0.61	1.00	2.00	180.00	0.20	0.40	0.50
155.82	RA	3.00	500.00	0.45	0.59	1.00	2.00	180.00	0.23	0.40	0.50
156.82	RA	3.00	500.00	0.40	0.66	1.07	2.00	180.00	0.20	0.43	0.54
157.82	RA	3.00	250.00	0.37	0.64	1.07	2.00	180.00	0.19	0.43	0.54
158.82	RA	0.00	0.00	0.50	0.73	1.33	2.00	180.00	0.25	0.52	0.67
159.82	RA	0.00	0.00	0.50	0.89	1.31	2.00	180.00	0.25	0.55	0.66
160.82	RA	1.50	150.00	0.50	0.71	1.06	2.00	180.00	0.25	0.44	0.53
161.82	RA	1.50	50.00	0.44	0.81	1.19	2.00	180.00	0.22	0.50	0.60
162.82	RA	3.00	100.00	0.40	0.56	0.84	1.70	180.00	0.24	0.41	0.49
163.82	RA	3.00	100.00	0.46	0.68	1.08	1.70	180.00	0.27	0.52	0.64
164.82	RA	3.00	100.00	0.43	0.58	0.89	1.70	180.00	0.25	0.43	0.52
165.82	RA	3.00	75.00	0.42	0.56	0.92	1.70	180.00	0.25	0.44	0.54
166.82	RA	3.00	50.00	0.46	0.62	0.95	1.70	180.00	0.27	0.46	0.56
167.82	RA	0.00	0.00	0.40	0.62	1.06	1.70	180.00	0.24	0.49	0.62
168.82	RA	0.00	0.00	0.54	0.87	1.35	1.70	180.00	0.32	0.65	0.79
169.82	RA	1.50	75.00	0.57	0.91	1.31	1.70	180.00	0.34	0.65	0.77
170.82	RA	1.50	150.00	0.45	0.66	0.97	1.70	180.00	0.26	0.48	0.57
171.82	RA	1.50	100.00	0.45	0.67	1.01	1.70	180.00	0.26	0.49	0.59
172.82									Both Baghouses Down for Maintenance		
173.82				Both Baghouses Down for Maintenance							
174.82				Both Baghouses Down for Maintenance							
175.82				Both Baghouses Down for Maintenance							
176.82				Both Baghouses Down for Maintenance							
177.82				Both Baghouses Down for Maintenance							
178.82				Both Baghouses Down for Maintenance							
179.82				Both Baghouses Down for Maintenance							
180.82				Both Baghouses Down for Maintenance							
181.82				Both Baghouses Down for Maintenance							
Averages	RA	1.88	137.50	0.44	0.67	1.04	1.80	180.00	0.24	0.47	0.58

TABLE A-13 (continued)

North Baghouse											
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extroltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
152.82	RA	0.00	0.00	0.25	0.43	0.58	1.00	180.00	0.25	0.51	0.58
153.82	RA	3.00	75.00	0.43	0.73	1.03	2.00	180.00	0.22	0.44	0.52
154.82	RA	3.00	500.00	0.43	0.69	1.08	2.00	180.00	0.22	0.44	0.54
155.82	RA	0.00	0.00	0.48	0.76	1.20	2.00	180.00	0.24	0.49	0.60
156.82	RA	0.00	0.00	0.52	0.89	1.43	2.00	180.00	0.26	0.58	0.72
157.82	RA	0.00	0.00	0.52	1.06	1.45	2.00	180.00	0.26	0.63	0.73
158.82	RA	3.00	500.00	0.50	0.64	1.25	2.00	180.00	0.25	0.47	0.63
159.82	RA	3.00	500.00	0.55	0.83	1.18	2.00	180.00	0.28	0.50	0.59
160.82	RA	1.50	300.00	0.56	0.80	1.16	2.00	180.00	0.28	0.49	0.58
161.82	RA	1.50	100.00	0.50	0.86	1.31	2.00	180.00	0.25	0.54	0.66
162.82	RA	3.00	150.00	0.43	0.63	0.95	1.70	180.00	0.25	0.46	0.56
163.82	RA	3.00	150.00	0.48	0.74	1.14	1.70	180.00	0.28	0.55	0.67
164.82	RA	3.00	150.00	0.44	0.64	0.95	1.70	180.00	0.26	0.47	0.56
165.82	RA	0.00	0.00	0.55	0.81	1.25	1.70	180.00	0.32	0.61	0.74
166.82	RA	0.00	0.00	0.56	0.81	1.35	1.70	180.00	0.33	0.64	0.79
167.82	RA	3.00	50.00	0.35	0.46	0.76	1.70	180.00	0.21	0.36	0.45
168.82	RA	3.00	100.00	0.37	0.56	0.82	1.70	180.00	0.22	0.41	0.48
169.82	RA	1.50	75.00	0.44	0.70	1.01	1.70	180.00	0.26	0.50	0.59
170.82	RA	1.50	150.00	0.45	0.64	0.93	1.70	180.00	0.26	0.46	0.55
171.82	RA	1.50	100.00	0.45	0.62	0.98	1.70	180.00	0.26	0.47	0.58
172.82											
173.82	Both Baghouses Down for Maintenance										
174.82	Both Baghouses Down for Maintenance										
175.82	Both Baghouses Down for Maintenance										
176.82	Both Baghouses Down for Maintenance										
177.82	Both Baghouses Down for Maintenance										
178.82	Both Baghouses Down for Maintenance										
179.82	Both Baghouses Down for Maintenance										
180.82	Both Baghouses Down for Maintenance										
181.82	Both Baghouses Down for Maintenance										
Averages	RA	1.73	145.00	0.46	0.72	1.09	1.80	180.00	0.26	0.50	0.60

TABLE A-14. DATA SUMMARY FOR JULY 1982

				South Baghouse							
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrold kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
182.82	RA	Both Baghouses Down For Maintenance									
183.82	RA	Both Baghouses Down For Maintenance									
184.82	RA	Both Baghouses Down For Maintenance									
185.82	RA	Both Baghouses Down For Maintenance									
186.82	RA	Both Baghouses Down For Maintenance									
187.82	RA	3.00	Not Avl.	Not Avl.	Not Avl.	Not Avl.	1.00	180.00	0.00	0.00	0.00
188.82	RA	3.00	Not Avl.	Not Avl.	Not Avl.	Not Avl.	1.00	180.00	0.00	0.00	0.00
189.82	RA	3.00	Not Avl.	Not Avl.	Not Avl.	Not Avl.	1.00	180.00	0.00	0.00	0.00
190.82	RA	3.00	Not Avl.	0.50	0.73	1.13	2.00	180.00	0.25	0.47	0.57
191.82	RA	3.00	Not Avl.	0.63	0.85	1.38	2.00	180.00	0.32	0.56	0.69
192.82	RA	3.00	Not Avl.	0.81	1.13	1.44	2.00	180.00	0.41	0.64	0.72
193.82	RA	3.00	Not Avl.	0.81	1.23	1.63	2.00	180.00	0.41	0.72	0.82
194.82	RA	3.00	Not Avl.	0.81	1.25	1.63	2.00	180.00	0.41	0.72	0.82
195.82	RA	3.00	Not Avl.	0.98	1.40	1.69	2.00	180.00	0.49	0.77	0.85
196.82	Baghouse Down										
197.82	RA	3.00	Not Avl.	0.69	1.06	1.50	2.00	180.00	0.35	0.64	0.75
198.82	RA	3.00	Not Avl.	0.69	0.90	1.35	2.00	180.00	0.35	0.56	0.68
199.82	RA	3.00	Not Avl.	0.73	1.06	1.38	2.00	180.00	0.37	0.61	0.69
200.82	RA	0.00	Not Avl.	0.78	1.15	1.56	2.00	180.00	0.39	0.68	0.78
201.82	RA	0.00	Not Avl.	0.81	1.06	1.63	2.00	180.00	0.41	0.67	0.82
202.82	RA	0.00	Not Avl.	1.00	1.38	1.69	2.00	180.00	0.50	0.77	0.85
203.82	RA	0.00	Not Avl.	1.00	1.40	1.65	2.00	180.00	0.50	0.76	0.83
204.82	RA	0.00	Not Avl.	0.85	1.19	1.65	2.00	180.00	0.43	0.71	0.83
205.82	RA	0.00	Not Avl.	1.03	1.31	1.81	2.00	180.00	0.52	0.78	0.91
206.82	RA	0.00	Not Avl.	0.94	1.28	1.75	2.00	180.00	0.47	0.76	0.88
207.82	RA	3.00	Not Avl.	0.90	1.31	1.73	2.00	180.00	0.45	0.76	0.87
208.82	RA	3.00	Not Avl.	0.94	1.53	1.85	2.00	180.00	0.47	0.85	0.93
209.82	RA	3.00	Not Avl.	1.13	1.73	2.40	2.00	180.00	0.57	1.03	1.20
210.82	Baghouse Down										
211.82	Baghouse Down										
212.82	Baghouse Down										
Averages	RA	2.05	Not Avl.	0.84	1.21	1.62	1.86	180.00	0.36	0.61	0.70

TABLE A-14 (continued)

North Baghouse

Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
182.82	Both Baghouses Down For Maintenance										
183.82	Both Baghouses Down For Maintenance										
184.82	Both Baghouses Down For Maintenance										
185.82	Both Baghouses Down For Maintenance										
186.82	Both Baghouses Down For Maintenance										
187.82	RA	3.00	Not Avl.	0.50	0.78	1.25	2.00	180.00	0.25	0.51	0.63
188.82	RA	3.00	Not Avl.	0.60	0.94	1.38	2.00	180.00	0.30	0.58	0.69
189.82	Baghouse Down										
190.82	Baghouse Down										
191.82	Baghouse Down										
192.82	Baghouse Down										
193.82	Baghouse Down										
194.82	Baghouse Down										
195.82	RA	3.00	Not Avl.	0.94	1.35	1.81	2.00	180.00	0.47	0.79	0.91
196.82	RA	3.00	Not Avl.	.98	1.48	1.9	2.00	180.00	0.49	0.85	0.95
197.82	RA	3.00	Not Avl.	1.10	1.48	1.94	2.00	180.00	0.55	0.86	0.97
198.82	RA	3.00	Not Avl.	0.85	1.31	1.75	2.00	180.00	0.43	0.77	0.88
199.82	RA	3.00	Not Avl.	1.03	1.56	1.98	2.00	180.00	0.52	0.89	0.99
200.82	RA	3.00	Not Avl.	1.35	1.90	2.31	2.00	180.00	0.68	1.05	1.16
201.82	RA	3.00	Not Avl.	1.25	1.78	2.25	2.00	180.00	0.63	1.01	1.13
202.82	RA	3.00	Not Avl.	1.31	1.94	2.38	2.00	180.00	0.66	1.08	1.19
203.82	RA	3.00	Not Avl.	1.44	1.90	2.31	2.00	180.00	0.72	1.05	1.16
204.82	RA	1.50	Not Avl.	1.44	1.81	2.19	2.00	180.00	0.72	1.00	1.10
205.82	RA	1.50	Not Avl.	1.38	1.81	2.25	2.00	180.00	0.69	1.02	1.13
206.82	RA	1.50	Not Avl.	1.40	1.81	2.23	2.00	180.00	0.70	1.01	1.12
207.82	RA	1.50	Not Avl.	1.50	1.90	2.28	2.00	180.00	0.75	1.05	1.14
208.82	RA	1.50	Not Avl.	1.44	1.88	2.28	2.00	180.00	0.72	1.04	1.14
209.82	RA	1.50	Not Avl.	1.56	2.06	2.44	2.00	180.00	0.78	1.13	1.22
210.82	RA	1.50	Not Avl.	1.13	1.48	1.8	2.00	180.00	0.57	0.82	0.90
211.82	RA	0.00	Not Avl.	1.16	1.54	1.91	2.00	180.00	0.58	0.86	0.96
212.82	RA	0.00	Not Avl.	1.25	1.69	1.98	2.00	180.00	0.63	0.92	0.99
Averages	RA	2.18	Not Avl.	1.18	1.62	2.03	2.00	180.00	0.59	0.91	1.02

TABLE A-15. DATA SUMMARY FOR AUGUST 1982

South Baghouse											
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrold kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
213.82	Conversion to Pulse-Jet										
214.82	Conversion to Pulse-Jet										
215.82	Conversion to Pulse-Jet										
216.82	Conversion to Pulse-Jet										
217.82	Conversion to Pulse-Jet										
218.82	Conversion to Pulse-Jet										
219.82	Conversion to Pulse-Jet										
220.82	Conversion to Pulse-Jet										
221.82	Conversion to Pulse-Jet										
222.82	Conversion to Pulse-Jet										
223.82	Conversion to Pulse-Jet										
224.82	Conversion to Pulse-Jet										
225.82	PJ	3.00	0.10	0.09	0.09	0.13	2.00	15.00	0.05	0.06	0.07
226.82	PJ	3.00	0.10	0.15	0.18	0.23	2.00	15.00	0.08	0.10	0.12
227.82	PJ	3.00	0.10	0.20	0.23	0.29	2.00	15.00	0.10	0.13	0.15
228.82	PJ	4.00	0.50	0.63	0.69	0.93	4.00	15.00	0.16	0.20	0.23
229.82	PJ	4.00	0.10	0.76	0.88	1.14	4.00	15.00	0.19	0.25	0.29
230.82	PJ	4.00	0.15	0.94	1.05	1.31	4.00	15.00	0.24	0.30	0.33
231.82	PJ	4.00	0.30	1.03	1.14	1.36	4.00	15.00	0.26	0.31	0.34
232.82	PJ	4.00	0.50	1.13	1.19	1.44	4.00	15.00	0.28	0.33	0.36
233.82	PJ	4.00	15.00	1.22	1.31	1.54	4.00	15.00	0.31	0.36	0.39
234.82	PJ	4.00	4.00	1.40	1.49	1.73	4.00	15.00	0.35	0.40	0.43
235.82	PJ	4.00	3.00	1.44	1.65	2.05	4.00	15.00	0.36	0.46	0.51
236.82	PJ	4.00	2.00	1.47	1.55	1.79	3.50	15.00	0.42	0.48	0.51
237.82	PJ	4.00	4.00	2.16	2.28	2.41	3.50	15.00	0.62	0.67	0.69
238.82	PJ	5.00	15.00	2.50	2.50	2.50	3.50	15.00	0.71	0.71	0.71
239.82	PJ	5.00	3.00	0.98	1.05	1.19	3.00	15.00	0.33	0.37	0.40
240.82	PJ	5.00	1.50	1.03	1.12	1.26	3.00	15.00	0.34	0.40	0.42
241.82	PJ	5.00	2.50	1.13	1.20	1.33	3.00	15.00	0.38	0.42	0.44
242.82	PJ	5.00	3.50	1.19	1.25	1.38	3.00	15.00	0.40	0.44	0.46
243.82	PJ	5.00	4.50	1.10	1.16	1.26	3.00	15.00	0.37	0.40	0.42
Averages	PJ	4.16	3.15	1.08	1.16	1.33	3.34	15.00	0.31	0.36	0.38

TABLE A-15 (continued)

North Baghouse											
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extroltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
213.82	RA	1.50	22.00	1.25	1.69	1.99	3.60	180.00	0.35	0.51	0.55
214.82	RA	1.50	19.00	1.60	2.13	2.50	3.60	180.00	0.44	0.64	0.69
215.82	RA	1.50	10.00	1.29	1.75	2.13	3.00	180.00	0.43	0.65	0.71
216.82	RA	1.50	9.00	1.38	1.86	2.25	3.00	180.00	0.46	0.69	0.75
217.82	RA	1.50	9.00	1.38	1.88	2.20	3.00	180.00	0.46	0.68	0.73
218.82	RA	1.50	24.00	1.20	1.65	1.93	3.00	180.00	0.40	0.60	0.64
219.82	RA	1.50	34.00	1.30	1.64	1.99	3.00	180.00	0.43	0.61	0.66
220.82	RA	1.50	15.00	1.28	1.71	2.03	3.00	180.00	0.43	0.62	0.68
221.82	RA	1.50	56.00	1.28	1.68	2.01	3.00	180.00	0.43	0.62	0.67
222.82	RA	1.50	14.00	1.28	1.69	2.01	3.00	180.00	0.43	0.62	0.67
223.82	RA	1.50	26.00	1.69	2.28	2.65	1.75	180.00	0.97	1.41	1.51
224.82	RA	1.50	23.00	1.60	2.14	2.68	1.75	180.00	0.91	1.38	1.53
225.82	RA	1.50	34.00	1.63	2.26	2.71	1.75	180.00	0.93	1.42	1.55
226.82	RA	1.50	36.00	1.65	2.28	2.71	1.75	180.00	0.94	1.43	1.55
227.82	RA	1.50	18.00	1.70	2.24	2.66	1.75	180.00	0.97	1.40	1.52
228.82	RA	2.00	205.00	1.65	2.18	2.57	1.75	180.00	0.94	1.36	1.47
229.82	RA	2.00	80.00	1.59	2.13	2.51	1.75	180.00	0.91	1.33	1.43
230.82	RA	2.00	45.00	1.57	2.14	2.55	1.75	180.00	0.90	1.34	1.46
231.82	RA	2.00	70.00	1.56	2.11	2.51	1.75	180.00	0.89	1.32	1.43
232.82	RA	2.00	195.00	1.59	2.11	2.48	1.50	180.00	1.06	1.53	1.65
233.82	RA	2.00	412.00	1.56	2.13	2.50	1.50	180.00	1.04	1.54	1.67
234.82	RA	2.00	367.00	1.63	2.15	2.51	1.50	180.00	1.09	1.55	1.67
235.82	RA	2.00	130.00	1.56	2.14	2.46	1.50	180.00	1.04	1.53	1.64
236.82	RA	2.00	172.00	1.59	2.06	2.44	2.00	180.00	0.80	1.13	1.22
237.82	RA	2.00	157.00	1.59	2.09	2.46	2.00	180.00	0.80	1.14	1.23
238.82	RA	3.10	243.00	1.69	2.19	2.53	2.00	180.00	0.85	1.18	1.27
239.82	RA	3.50	172.00	1.73	2.26	2.60	1.70	180.00	1.02	1.43	1.53
240.82	RA	3.50	118.00	1.75	2.33	2.69	1.70	180.00	1.03	1.48	1.58
241.82	RA	Data Not Available									
242.82	RA	3.80	163.00	0.64	0.83	0.94	1.00	180.00	0.64	0.89	0.94
243.82	RA	3.60	185.00	0.62	0.74	0.86	1.00	180.00	0.62	0.80	0.86
Averages	RA	2.00	102.10	1.46	1.95	2.30	2.15	180.00	0.75	1.09	1.18

TABLE A-16. DATA SUMMARY FOR SEPTEMBER 1982

					South Baghouse						
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrold kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
244.82	PJ	5.00	4.50	1.26	1.34	1.48	3.00	15.00	0.42	0.47	0.49
245.82	PJ	4.00	200.00	2.22	2.35	2.48	3.00	15.00	0.74	0.81	0.83
246.82	PJ	4.00	130.00	1.19	1.26	1.34	4.00	15.00	0.30	0.33	0.34
247.82	PJ	4.90	55.00	1.18	1.23	1.32	4.00	15.00	0.30	0.32	0.33
248.82	PJ	4.90	48.00	1.18	1.23	1.32	4.00	15.00	0.30	0.32	0.33
249.82	PJ	4.90	40.00	1.16	1.22	1.30	4.00	15.00	0.29	0.32	0.33
250.82	PJ	0.00	0.00	1.10	1.20	1.29	4.00	15.00	0.28	0.31	0.32
251.82	PJ	0.00	0.00	1.17	1.25	1.37	4.00	15.00	0.29	0.33	0.34
252.82	PJ	0.00	0.00	1.24	1.33	1.43	4.00	15.00	0.31	0.35	0.36
253.82	PJ	0.00	0.00	1.28	1.37	1.47	4.00	15.00	0.32	0.36	0.37
254.82	PJ	0.00	0.00	1.22	1.31	1.39	4.00	15.00	0.31	0.34	0.35
255.82	PJ	Data Not Available									
256.82	PJ	Data Not Available									
257.82	PJ	New Bags Installed									
258.82	PJ	3.00	15.00	0.06	0.06	1.45	1.90	750.00	0.03	0.40	0.76
259.82	PJ	3.00	9.00	0.06	0.30	1.40	1.90	573.00	0.03	0.45	0.74
260.82	PJ	3.00	7.00	0.14	0.18	0.36	3.85	15.00	0.04	0.07	0.09
261.82	PJ	3.00	6.00	0.22	0.31	0.49	4.00	15.00	0.06	0.10	0.12
262.82	PJ	3.00	3.00	0.29	0.38	0.60	4.00	15.00	0.07	0.12	0.15
263.82	PJ	3.00	4.00	0.33	0.46	0.64	4.00	15.00	0.08	0.14	0.16
264.82	PJ	3.00	3.00	0.41	0.53	0.71	4.00	15.00	0.10	0.16	0.18
265.82	PJ	3.00	4.00	0.45	0.59	0.76	4.00	15.00	0.11	0.17	0.19
266.82	PJ	3.00	3.00	0.48	0.61	0.77	4.00	15.00	0.12	0.17	0.19
267.82	PJ	3.00	2.50	0.49	0.64	0.80	4.00	15.00	0.12	0.18	0.20
268.82	PJ	3.00	3.00	0.47	0.63	0.79	4.00	15.00	0.12	0.18	0.20
269.82	PJ	3.00	3.00	0.49	0.63	0.78	4.00	15.00	0.12	0.18	0.20
270.82	PJ	3.00	3.00	0.47	0.59	0.74	4.00	15.00	0.12	0.17	0.19
271.82	PJ	3.00	5.00	0.48	0.62	0.79	4.00	15.00	0.12	0.18	0.20
272.82	PJ	3.00	3.00	0.59	0.87	1.03	4.00	15.00	0.15	0.24	0.26
273.82	PJ	3.00	2.00	0.44	0.56	0.71	4.00	15.00	0.11	0.16	0.18
Averages	PJ	2.80	20.48	0.74	0.85	1.07	3.76	62.89	0.20	0.27	0.31

TABLE A-16 (continued)

Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
					North Baghouse						
244.82	RA	0.50	168.00	1.19	1.54	1.76	1.00	180.00	1.19	1.65	1.76
245.82	RA	0.50	500.00	1.25	1.78	2.24	1.00	180.00	1.25	2.01	2.24
246.82	RA	2.80	500.00	1.25	1.70	2.01	1.25	180.00	1.00	1.48	1.61
247.82	RA	2.80	500.00	1.22	1.64	1.93	1.25	180.00	0.98	1.43	1.54
248.82	RA	2.80	500.00	1.23	1.66	1.93	1.25	180.00	0.98	1.44	1.54
249.82	RA	3.80	500.00	1.19	1.64	1.89	1.25	180.00	0.95	1.41	1.51
250.82	RA	0.00	0.00	1.31	1.76	2.06	1.25	180.00	1.05	1.53	1.65
251.82	RA	0.00	0.00	1.44	1.91	2.21	1.25	180.00	1.15	1.65	1.77
252.82	RA	0.00	0.00	1.34	1.93	2.26	1.25	180.00	1.07	1.68	1.81
253.82	RA	0.00	0.00	1.38	1.95	2.29	1.25	180.00	1.10	1.70	1.83
254.82	RA	0.00	0.00	1.38	1.93	2.19	1.25	180.00	1.10	1.65	1.75
255.82	RA	Data Not Available									
256.82	RA	3.80	500.00	1.44	1.84	2.09	1.25	180.00	1.15	1.57	1.67
257.82	RA	3.80	500.00	1.44	1.84	2.09	1.35	180.00	1.07	1.46	1.55
258.82	RA	3.80	500.00	1.34	1.76	2.04	1.35	180.00	0.99	1.41	1.51
259.82	RA	3.80	475.00	1.38	1.77	2.02	1.20	180.00	1.15	1.58	1.68
260.82	RA	3.80	500.00	1.31	1.71	1.98	1.30	180.00	1.01	1.42	1.52
261.82	RA	3.80	450.00	1.25	1.70	1.94	1.30	180.00	0.96	1.40	1.49
262.82	RA	3.80	285.00	1.31	1.71	1.96	1.30	180.00	1.01	1.41	1.51
263.82	RA	3.80	375.00	1.31	1.71	1.99	1.30	180.00	1.01	1.42	1.53
264.82	RA	3.80	400.00	1.31	1.70	1.97	1.40	180.00	0.94	1.31	1.41
265.82	RA	3.80	400.00	1.28	1.74	2.00	1.40	180.00	0.91	1.34	1.43
266.82	RA	3.80	400.00	1.31	1.74	2.01	1.40	180.00	0.94	1.34	1.44
267.82	RA	3.80	400.00	1.28	1.74	1.99	1.40	180.00	0.91	1.33	1.42
268.82	RA	3.80	400.00	1.31	1.74	1.99	1.40	180.00	0.94	1.33	1.42
269.82	RA	3.80	400.00	1.31	1.73	1.96	1.40	180.00	0.94	1.32	1.40
270.82	RA	3.80	350.00	1.31	1.69	1.93	1.40	180.00	0.94	1.29	1.38
271.82	RA	3.80	400.00	1.31	1.70	1.99	1.40	180.00	0.94	1.32	1.42
272.82	RA	3.80	400.00	1.31	1.73	1.95	1.40	180.00	0.94	1.31	1.39
273.82	RA	3.80	289.00	1.31	1.65	1.87	1.40	180.00	0.94	1.26	1.34
Averages	RA	2.81	348.00	1.31	1.75	2.02	1.30	180.00	1.02	1.46	1.57

TABLE A-17. DATA SUMMARY FOR OCTOBER 1982

				South Baghouse							
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrold kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
274.82	PJ	0.00	0.00	0.50	0.60	0.81	4.00	15.00	0.13	0.18	0.20
275.82	PJ	0.00	0.00	0.50	0.66	0.90	4.00	15.00	0.13	0.20	0.23
276.82	PJ	0.00	0.00	0.59	0.73	0.94	4.00	15.00	0.15	0.21	0.24
277.82	PJ	0.00	0.00	0.59	0.75	1.00	4.00	15.00	0.15	0.22	0.25
278.82	PJ	0.00	0.00	0.63	0.80	1.05	4.00	15.00	0.16	0.23	0.26
279.82	PJ	3.00	2.00	0.50	0.63	0.78	4.00	15.00	0.13	0.18	0.20
280.82	PJ	3.00	2.00	0.50	0.63	0.80	4.00	15.00	0.13	0.18	0.20
281.82	PJ	3.00	2.00	0.50	0.63	0.83	4.00	15.00	0.13	0.18	0.21
282.82	PJ	3.00	2.00	0.50	0.61	0.84	4.00	15.00	0.13	0.18	0.21
283.82	PJ	3.00	2.00	0.60	0.71	0.93	4.00	15.00	0.15	0.21	0.23
284.82	PJ	3.00	2.00	0.78	0.89	1.15	4.00	15.00	0.20	0.26	0.29
285.82	PJ	3.00	2.00	0.81	0.99	1.21	4.00	15.00	0.20	0.28	0.30
286.82	PJ	3.00	2.00	0.73	0.85	1.05	4.00	15.00	0.18	0.24	0.26
287.82	PJ	3.00	2.00	0.64	0.76	0.96	4.00	15.00	0.16	0.22	0.24
288.82	PJ	3.00	2.00	0.65	0.80	1.05	4.00	15.00	0.16	0.23	0.26
289.82	PJ	3.00	2.00	0.84	0.98	1.18	4.00	15.00	0.21	0.27	0.30
290.82	PJ	3.00	2.00	0.93	1.00	1.24	4.00	15.00	0.23	0.28	0.31
291.82	PJ	Baghouse Blinded									
292.82	PJ	3.00	2.00	0.75	0.88	1.08	4.00	15.00	0.19	0.25	0.27
293.82	PJ	3.00	2.00	0.66	0.75	0.97	4.30	15.00	0.15	0.20	0.23
294.82	PJ	3.00	2.00	0.82	0.92	1.10	4.30	15.00	0.19	0.23	0.26
295.82	PJ	0.00	0.00	0.96	1.08	1.33	4.50	15.00	0.21	0.27	0.30
296.82	PJ	0.00	0.00	2.50	2.50	2.50	4.00	15.00	0.63	0.63	0.63
297.82	PJ	0.00	0.00	2.50	2.50	2.50	4.00	15.00	0.63	0.63	0.63
298.82	PJ	0.00	0.00	2.50	2.50	2.50	4.00	15.00	0.63	0.63	0.63
299.82	PJ	0.00	0.00	0.72	0.87	1.08	3.00	15.00	0.24	0.33	0.36
300.82	PJ	0.00	0.00	0.75	0.90	1.08	3.00	15.00	0.25	0.33	0.36
301.82	PJ	0.00	0.00	0.69	0.81	1.03	3.00	15.00	0.23	0.31	0.34
302.82	PJ	3.00	2.00	1.31	1.41	1.76	5.00	15.00	0.26	0.32	0.35
303.82	PJ	3.00	2.00	2.50	2.50	2.50	5.00	15.00	0.50	0.50	0.50
304.82	PJ	3.00	2.00	2.50	2.50	2.50	5.00	15.00	0.50	0.50	0.50
Averages	PJ	1.80	1.20	1.00	1.10	1.29	4.04	15.00	0.24	0.29	0.32

TABLE A-17 (continued)

				North	Baghouse						
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
274.82	RA	0.00	0.00	1.31	1.81	2.18	1.40	180.00	0.94	1.43	1.56
275.82	RA	0.00	0.00	1.38	1.95	2.33	1.40	180.00	0.99	1.53	1.66
276.82	RA	0.00	0.00	1.44	2.06	2.38	1.40	180.00	1.03	1.59	1.70
277.82	RA	0.00	0.00	1.49	2.09	2.38	1.40	180.00	1.06	1.60	1.70
278.82	RA	0.00	0.00	1.50	2.08	2.40	1.40	180.00	1.07	1.60	1.71
279.82	RA	2.20	290.00	1.39	1.84	2.04	1.40	180.00	0.99	1.39	1.46
280.82	RA	2.20	220.00	1.38	1.83	2.03	1.40	180.00	0.99	1.38	1.45
281.82	RA	2.20	25.00	New Bags-One Cleaning Cycle All Day							
282.82	RA	2.20	10.00	New Bags-One Cleaning Cycle All Day							
283.82	RA	2.20	5.00	New Bags-One Cleaning Cycle All Day							
284.82	RA	2.20	6.00	0.16	0.95	1.30	1.00	730.00	0.16	1.13	1.30
285.82	RA	2.20	30.00	0.75	1.55	1.98	2.00	180.00	0.38	0.88	0.99
286.82	RA	2.20	15.00	0.75	1.55	1.95	2.00	180.00	0.38	0.88	0.98
287.82	RA	2.20	30.00	0.81	1.56	2.00	2.00	180.00	0.41	0.89	1.00
288.82	RA	2.20	50.00	1.05	1.58	2.00	1.50	180.00	0.70	1.19	1.33
289.82	RA	2.20	20.00	1.00	1.80	2.19	1.50	180.00	0.67	1.33	1.46
290.82	RA	2.20	15.00	1.19	1.84	2.30	1.50	180.00	0.79	1.38	1.53
291.82	RA	Baghouse Blinded									
292.82	RA	Baghouse Down									
293.82	RA	2.20	50.00	1.31	2.00	2.43	2.00	180.00	0.66	1.11	1.22
294.82	RA	2.20	75.00	1.32	2.07	2.07	2.00	180.00	0.66	1.04	1.04
295.82	RA	2.20	300.00	1.25	1.59	2.06	2.00	180.00	0.63	0.91	1.03
296.82	RA	2.20	500.00	1.37	1.87	2.42	2.00	180.00	0.69	1.07	1.21
297.82	RA	2.20	400.00	1.56	2.07	2.74	2.00	180.00	0.78	1.20	1.37
298.82	RA	2.20	350.00	1.56	2.03	2.62	2.00	180.00	0.78	1.16	1.31
299.82	RA	2.20	350.00	1.31	1.62	2.12	1.60	180.00	0.82	1.17	1.33
300.82	RA	2.20	350.00	2.18	2.44	2.87	1.60	180.00	1.36	1.66	1.79
301.82	RA	2.20	350.00	2.37	2.50	3.00	1.60	180.00	1.48	1.72	1.88
302.82	RA	2.20	75.00	0.87	0.95	1.22	1.50	180.00	0.58	0.72	0.81
303.82	RA	2.20	75.00	2.50	2.50	2.50	1.50	180.00	1.67	1.67	1.67
304.82	RA	2.20	75.00	2.50	2.50	2.50	1.50	180.00	1.67	1.67	1.67
Averages	RA	1.82	126.41	1.37	1.87	2.23	1.64	201.15	0.86	1.28	1.39

TABLE A-18. DATA SUMMARY FOR NOVEMBER 1982

		South Baghouse									
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpld kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
305.82	PJ	Bags Blinded									
306.82	PJ	Bags Blinded									
307.82	PJ	3.00	5.00	0.45	0.56	0.72	4.00	15.00	0.11	0.16	0.18
308.82	PJ	3.00	5.00	0.56	0.69	0.83	4.00	15.00	0.14	0.19	0.21
309.82	PJ	3.00	5.00	0.67	0.80	0.92	4.00	15.00	0.17	0.22	0.23
310.82	PJ	3.00	5.00	0.65	0.86	0.98	4.00	15.00	0.16	0.23	0.25
311.82	PJ	3.00	5.00	0.69	0.77	0.92	4.00	15.00	0.17	0.21	0.23
312.82	PJ	3.00	Not Avl.	0.60	0.66	0.86	3.75	15.00	0.16	0.20	0.23
313.82	PJ	3.00	Not Avl.	0.82	0.92	1.12	3.75	15.00	0.22	0.27	0.30
314.82	PJ	3.00	Not Avl.	0.96	1.05	1.26	3.75	15.00	0.26	0.31	0.34
315.82	PJ	3.00	Not Avl.	1.02	1.12	1.33	3.75	15.00	0.27	0.33	0.35
316.82	PJ	3.00	Not Avl.	0.97	1.12	1.37	3.75	15.00	0.26	0.33	0.37
317.82	PJ	3.00	Not Avl.	1.46	1.57	1.81	3.75	15.00	0.39	0.45	0.48
318.82	PJ	3.00	Not Avl.	2.12	2.19	2.34	3.75	15.00	0.57	0.60	0.62
319.82	PJ	3.00	Not Avl.	New Bags-Pressure Drop Clean							
320.82	PJ	3.00	Not Avl.	New Bags-Pressure Drop Clean							
321.82	PJ	3.00	Not Avl.	New Bags-Pressure Drop Clean							
322.82	PJ	3.00	Not Avl.	New Bags-Pressure Drop Clean							
323.82	PJ	3.00	Not Avl.	0.19	0.19	0.22	2.00	15.00	0.10	0.10	0.11
324.82	PJ	3.00	Not Avl.	0.20	0.22	0.26	2.00	15.00	0.10	0.12	0.13
325.82	PJ	3.00	Not Avl.	0.16	0.20	0.24	2.00	15.00	0.08	0.11	0.12
326.82	PJ	3.00	Not Avl.	0.19	0.22	0.25	2.00	15.00	0.10	0.12	0.13
327.82	PJ	3.00	Not Avl.	0.16	0.20	0.22	2.00	15.00	0.08	0.11	0.11
328.82	PJ	3.00	Not Avl.	0.27	0.31	0.36	2.00	15.00	0.14	0.17	0.18
329.82	Data Not Available										
330.82	Data Not Available										
331.20	Data Not Available										
332.82											
333.82	PJ	3.00	Not Avl.	0.55	0.65	0.81	4.00	15.00	0.14	0.18	0.20
334.82	PJ	3.00	Not Avl.	0.62	0.72	0.92	4.00	15.00	0.16	0.21	0.23
Averages	PJ	3.00	5.00	0.67	0.75	0.89	3.31	15.00	0.19	0.23	0.25

TABLE A-18 (continued)

						North Baghouse					
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
305.82	RA					Bags Blinded					
306.82	RA					Bags Blinded					
307.82	RA	0.00	0.00	0.85	1.00	1.18	1.50	180.00	0.57	0.73	0.79
308.82	RA	0.00	0.00	1.36	1.57	1.82	1.50	180.00	0.91	1.13	1.21
309.82	RA	0.00	0.00	0.92	1.30	1.67	1.50	180.00	0.61	0.99	1.11
310.82	RA	0.00	0.00	0.96	1.41	1.73	1.50	180.00	0.64	1.05	1.15
311.82	RA	0.00	0.00	0.93	1.41	1.78	1.50	180.00	0.62	1.06	1.19
312.82	RA	2.20	Not Avl.	0.81	0.90	1.32	1.20	180.00	0.68	0.93	1.10
313.82	RA	2.20	Not Avl.	1.31	1.75	2.18	1.20	180.00	1.09	1.64	1.82
314.82	RA	2.20	Not Avl.	1.31	1.82	2.22	1.20	180.00	1.09	1.68	1.85
315.82	RA	2.20	Not Avl.	1.18	1.41	1.79	1.20	180.00	0.98	1.33	1.49
316.82	RA	2.20	Not Avl.	1.06	1.33	1.71	1.20	180.00	0.88	1.27	1.43
317.82	RA	2.20	Not Avl.	1.22	1.58	2.01	1.20	180.00	1.02	1.50	1.68
318.82	RA	2.20	Not Avl.	1.18	1.48	1.94	1.20	180.00	0.98	1.43	1.62
319.82	RA	2.20	Not Avl.	1.31	1.68	2.07	1.20	180.00	1.09	1.56	1.73
320.82	RA	2.20	Not Avl.	1.37	1.74	2.16	1.20	180.00	1.14	1.63	1.80
321.82	RA	2.20	Not Avl.	1.30	1.57	2.00	1.20	180.00	1.08	1.49	1.67
322.82	RA	2.20	Not Avl.	1.32	1.67	2.13	1.20	180.00	1.10	1.58	1.78
323.82	RA	2.20	Not Avl.	1.25	1.42	1.84	1.20	180.00	1.04	1.36	1.53
324.82	RA	2.20	Not Avl.	1.18	1.42	1.83	1.20	180.00	0.98	1.35	1.53
325.82	RA	2.20	Not Avl.	1.25	1.45	2.00	1.20	180.00	1.04	1.44	1.67
326.82	RA	2.20	Not Avl.	1.18	1.37	1.87	1.20	180.00	0.98	1.35	1.56
327.82	RA	2.20	Not Avl.	1.27	1.42	1.84	1.20	180.00	1.06	1.36	1.53
328.82	RA	2.20	Not Avl.	1.37	1.69	2.09	1.20	180.00	1.14	1.58	1.74
329.82					Data Not Available						
330.82					Data Not Available						
331.20					Data Not Available						
332.82											
333.82	RA	2.20	Not Avl.	1.06	1.27	1.62	1.50	180.00	0.71	0.96	1.08
334.82	RA	2.20	Not Avl.	1.13	1.43	1.73	1.50	180.00	0.75	1.05	1.15
Averages	RA	1.74	0.00	1.17	1.46	1.86	1.29	180.00	0.92	1.31	1.47

TABLE A-19. DATA SUMMARY FOR DECEMBER 1982

				South Baghouse							
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrold kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
335.82	PJ	3.00	Not Avl.	0.65	0.70	0.95	4.00	15.00	0.16	0.21	0.24
336.82	PJ	3.00	Not Avl.	0.69	0.75	0.97	4.00	15.00	0.17	0.22	0.24
337.82	PJ	3.00	20.00	0.65	0.74	1.01	4.00	15.00	0.16	0.22	0.25
338.82	PJ	3.00	20.00	0.72	0.80	1.10	4.00	15.00	0.18	0.24	0.28
339.82	PJ	Data Not Available									
340.82	PJ	Data Not Available									
341.82	PJ	3.00	30.00	0.78	0.88	1.10	4.00	15.00	0.20	0.25	0.28
342.82	PJ	3.00	35.00	0.85	0.95	1.15	4.00	15.00	0.21	0.26	0.29
343.82	PJ	3.00	35.00	0.93	1.02	1.21	4.00	15.00	0.23	0.28	0.30
344.82	PJ	3.00	40.00	0.93	1.01	1.16	4.00	15.00	0.23	0.27	0.29
345.82	PJ	3.00	27.00	0.92	1.02	1.22	4.00	15.00	0.23	0.28	0.31
346.82	PJ	3.00	23.00	1.07	1.15	1.33	4.00	15.00	0.27	0.31	0.33
347.82	PJ	0.00	0.00	1.05	1.12	1.40	4.00	15.00	0.26	0.32	0.35
348.82	PJ	0.00	0.00	1.12	1.21	1.45	4.00	15.00	0.28	0.33	0.36
349.82	PJ	0.00	0.00	1.12	1.25	1.59	4.00	15.00	0.28	0.36	0.40
350.82	PJ	0.00	0.00	1.02	1.13	1.37	4.00	15.00	0.26	0.31	0.34
351.82	PJ	0.00	0.00	0.71	0.88	1.12	4.00	15.00	0.18	0.25	0.28
352.82	PJ	3.00	Not Avl.	0.77	0.91	1.12	4.00	15.00	0.19	0.25	0.28
353.82	PJ	3.00	Not Avl.	0.87	1.00	1.22	4.00	15.00	0.22	0.28	0.31
354.82	PJ	3.00	15.00	0.75	0.91	1.08	4.00	15.00	0.19	0.25	0.27
355.82	PJ	3.00	7.00	0.70	0.92	1.10	4.00	15.00	0.18	0.25	0.28
356.82	PJ	3.00	10.00	0.82	1.23	1.42	4.00	15.00	0.21	0.33	0.36
357.82	PJ	3.00	7.00	0.75	0.96	1.17	4.00	15.00	0.19	0.27	0.29
358.82	PJ	3.00	7.00	0.69	0.86	1.05	4.00	15.00	0.17	0.24	0.26
359.82	PJ	3.00	54.00	0.70	0.88	1.07	4.00	15.00	0.18	0.24	0.27
360.82	PJ	3.00	60.00	0.75	0.87	1.67	4.00	15.00	0.19	0.32	0.42
361.82	PJ	3.00	67.00	0.70	0.87	1.07	4.00	15.00	0.18	0.24	0.27
362.82	PJ	3.00	70.00	0.69	0.83	0.98	4.00	15.00	0.17	0.23	0.25
363.82	PJ	3.00	65.00	0.75	0.90	1.07	4.00	15.00	0.19	0.25	0.27
364.82	PJ	0.00	0.00	0.81	0.98	1.21	4.00	15.00	0.20	0.27	0.30
365.82	PJ	0.00	0.00	0.81	0.97	1.18	4.00	15.00	0.20	0.27	0.30
Averages	PJ	2.28	23.68	0.82	0.96	1.19	4.00	15.00	0.20	0.27	.2977586

TABLE A-19 (continued)

					North Baghouse						
Julian Date day.year	Status	Field kV/cm	Current microamps	Delta P Residual kPa	Delta P Extrpltd kPa	Delta P Final kPa	Face Velocity cm/s	Cleaning Cycle min	Drag Residual kPa*s/cm	Drag Average kPa*s/cm	Drag Final kPa*s/cm
335.82	RA	2.20	Not Avl.	1.12	1.35	1.81	1.50	180.00	0.75	1.05	1.21
336.82	RA	2.20	Not Avl.	1.18	1.50	1.98	1.50	180.00	0.79	1.16	1.32
337.82	RA	2.20	600.00	1.13	1.33	1.87	1.50	180.00	0.75	1.07	1.25
338.82	RA	2.20	450.00	1.07	1.31	1.68	1.50	180.00	0.71	1.00	1.12
339.82	RA	2.20	500.00	1.12	1.35	1.76	1.50	180.00	0.75	1.04	1.17
340.82	RA	2.20	650.00	1.21	1.47	1.96	1.50	180.00	0.81	1.14	1.31
341.82	RA	2.20	550.00	1.18	1.43	1.87	1.50	180.00	0.79	1.10	1.25
342.82	RA	2.20	450.00	1.18	1.45	1.82	1.50	180.00	0.79	1.09	1.21
343.82	RA	2.20	450.00	1.25	1.50	1.87	1.50	180.00	0.83	1.12	1.25
344.82	RA	2.20	430.00	1.18	1.38	1.67	1.50	180.00	0.79	1.02	1.11
345.82	RA	2.20	340.00	1.22	1.46	1.78	1.50	180.00	0.81	1.08	1.19
346.82	RA	2.20	360.00	1.25	1.52	1.88	1.50	180.00	0.83	1.13	1.25
347.82	RA	2.20	360.00	1.31	1.67	2.06	1.50	180.00	0.87	1.24	1.37
348.82	RA	2.20	370.00	1.25	1.69	2.04	1.50	180.00	0.83	1.24	1.36
349.82	RA	2.20	250.00	1.41	1.75	2.16	1.50	180.00	0.94	1.30	1.44
350.82	RA	0.00	0.00	1.37	1.69	2.06	1.50	180.00	0.91	1.25	1.37
351.82	RA	0.00	0.00	1.37	1.79	2.12	1.50	180.00	0.91	1.30	1.41
352.82	RA	0.00	0.00	1.43	1.75	2.08	1.50	180.00	0.95	1.28	1.39
353.82	RA	0.00	0.00	1.37	1.79	2.09	1.50	180.00	0.91	1.29	1.39
354.82	RA	0.00	0.00	1.25	1.64	2.01	1.50	180.00	0.83	1.22	1.34
355.82	RA	0.00	0.00	1.27	1.68	2.03	1.50	180.00	0.85	1.24	1.35
356.82	RA	0.00	0.00	1.35	1.69	2.09	1.50	180.00	0.90	1.26	1.39
357.82	RA	0.00	0.00	1.75	2.25	2.68	1.50	180.00	1.17	1.64	1.79
358.82	RA	0.00	0.00	1.74	2.19	2.68	1.50	180.00	1.16	1.62	1.79
359.82	RA	0.00	0.00	1.87	2.32	2.74	1.50	180.00	1.25	1.69	1.83
360.82	RA	0.00	0.00	1.88	2.34	2.74	1.50	180.00	1.25	1.69	1.83
361.82	RA	0.00	0.00	2.00	>2.37	>2.74	1.50	180.00	1.33	> 1.58	> 1.83
362.82	RA	2.40	200.00	1.56	1.87	2.17	1.50	180.00	1.04	1.35	1.45
363.82	RA	2.40	200.00	1.55	1.88	2.26	1.50	180.00	1.03	1.38	1.51
364.82	RA	0.00	0.00	1.59	1.94	2.37	1.50	180.00	1.06	1.44	1.58
365.82	RA	0.00	0.00	1.67	2.02	2.37	1.50	180.00	1.11	1.46	1.58
Averages	RA	1.22	212.41	1.39	1.70	2.09	1.50	180.00	0.93	1.26	1.39

APPENDIX B

FINE PARTICLES TEST PROGRAM

B.1 INTRODUCTION

The fine particles test program at the ESFF pilot unit was undertaken to provide information concerning the effect of ESFF on the size distributions in a fabric filter. The program dealt with the particle size spectrum from about .01 to 10 micrometers. Cascade impactor sizing had been done during the pulse-jet test program; thus some information was available for the larger size range. This was the first work done with an ESFF filter in the ultrafine size region. Full knowledge of the size-dependent particle removal efficiency is basic to understanding the ESFF effect. The objective of the program was to obtain inlet and outlet size distribution for the ESFF and control baghouses, and to determine size-dependent particle removal efficiency for both baghouses.

The instruments used during the test program were cascade impactors, electrical aerosol analyzers (EAA), and an optical particle counter. The test was run from May 18 through May 22, 1981. The general plan of the program was that May 18 was used to set up equipment; May 19, a full test day with both cascade impactors and EAAs in use, and May 20, a day to clean and prepare the impactors while using the EAAs and Climet to do a real-time study of the baghouse operation. May 21 was to be another complete sizing test using both EAAs and impactors, and May 22, a cleanup and travel day.

B.2 ULTRAFINE PARTICLE SAMPLING

The ultrafine particle sampling system consisted of the following:

- Inlet System
  - One diluter as close to the sample port as possible.
  - A diffusion dryer just downstream of the first diluter.

- Two out-of-stack diluters.
- EAA with output to strip chart recorder.
- Climet optical particle counter.

- Outlet System
  - One diluter as close to the sample port as possible.
  - A diffusion dryer just downstream of the diluter.
  - EAA with output to strip chart recorder.
  - Climet optical particle counter.

Figure B-1 is a schematic of the ultrafine particle sampling system. The inlet and outlet systems were essentially the same except that extra dilution was used on the baghouse inlet.

The diluters were of the porous wall design. The aerosol flowing through the porous wall tube was diluted by dry air passing through the wall. Each diluter was capable of making a 10:1 dilution of the incoming aerosol at acceptable loss levels. These diluters had been field tested previously and shown to be suitable.

B.3 ULTRAFINE PARTICLE SAMPLING PROTOCOL

The ultimate objective of the ultrafine particle tests is to obtain quality size distribution and penetration results for particles below 1 micrometer diameter. The following steps constitute the protocol followed to ensure quality data:

1. Laboratory checkout.
   a. Leak check the assembled system.
   b. Check diluter operation with ambient aerosol to determine linearity.
   c. Operate all equipment including the particle sensors.
   d. Calibrate all flowmeters.

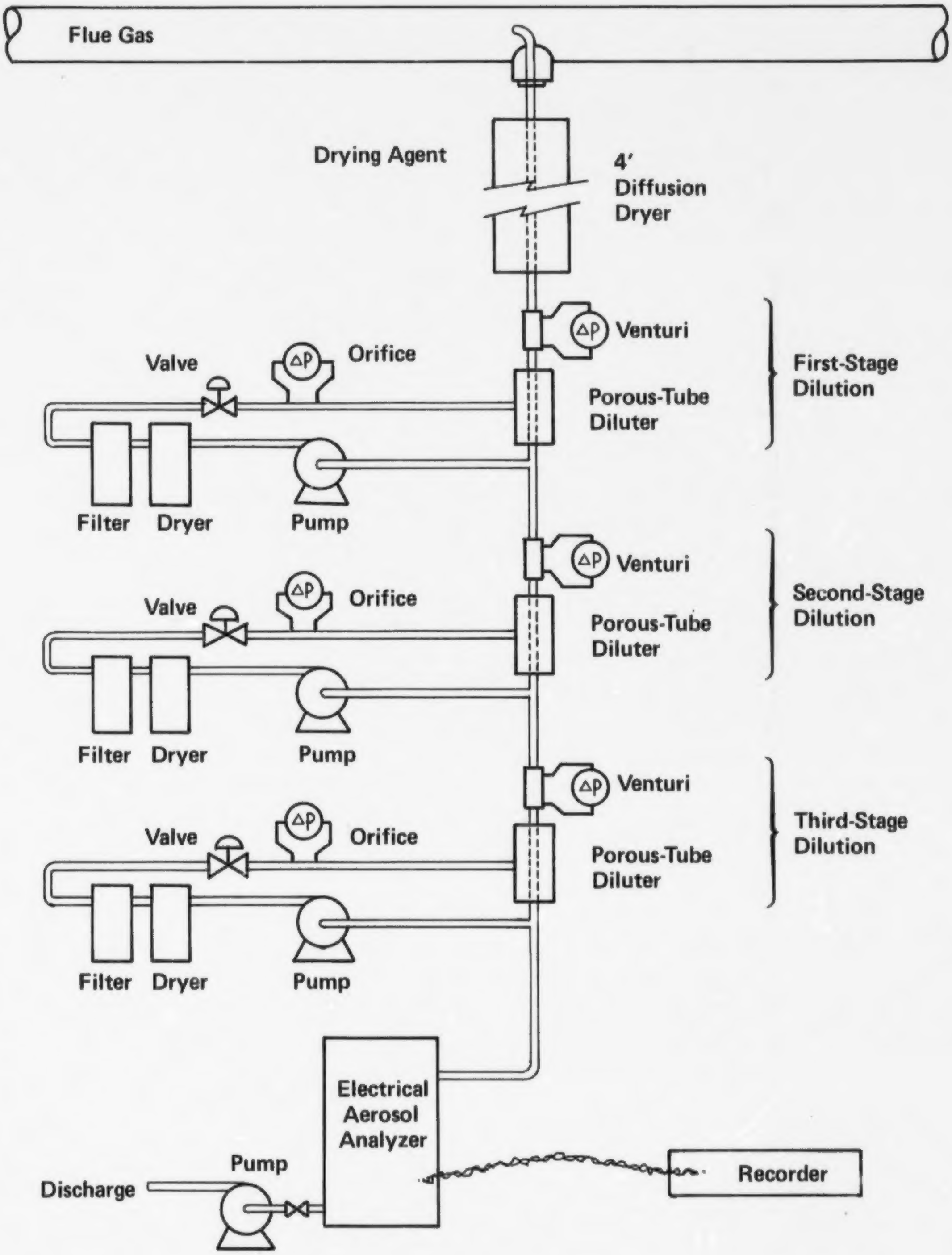

Flue Gas
Drying Agent
4' Diffusion Dryer
ΔP
Venturi
Valve
ΔP
Orifice
Porous-Tube Diluter
First-Stage Dilution
Filter
Dryer
Pump
ΔP
Venturi
Valve
ΔP
Orifice
Porous-Tube Diluter
Second-Stage Dilution
Filter
Dryer
Pump
ΔP
Venturi
Valve
ΔP
Orifice
Porous-Tube Diluter
Third-Stage Dilution
Filter
Dryer
Pump
Electrical Aerosol Analyzer
Pump
Discharge
Recorder

Figure B-1. Schematic drawing of EAA Sample System.

2. Field checkout

   a. Operate all instruments on one aerosol source and compare results between instruments.

   b. Adjust the instruments so that all respond similarly.

3. Operating hints

   a. Watch very carefully for the formation of moisture in the dilution system. All dilution air must be dry.

   b. Take measurements using both the continuous particle distribution scan and single modes.

   c. Use two or three different dilutions to see if the dilution system is linear.

   d. Perform rough workups of the data in the field to see if they make sense when compared to other particle size measurements.

B.4 IMPACTOR TEST PROCEDURES

1. Obtain a duct center-line velocity and stack pressure. Use pitot tube for velocity and static probe for static pressure. Note duct orifice reading and maintain flow by orifice.

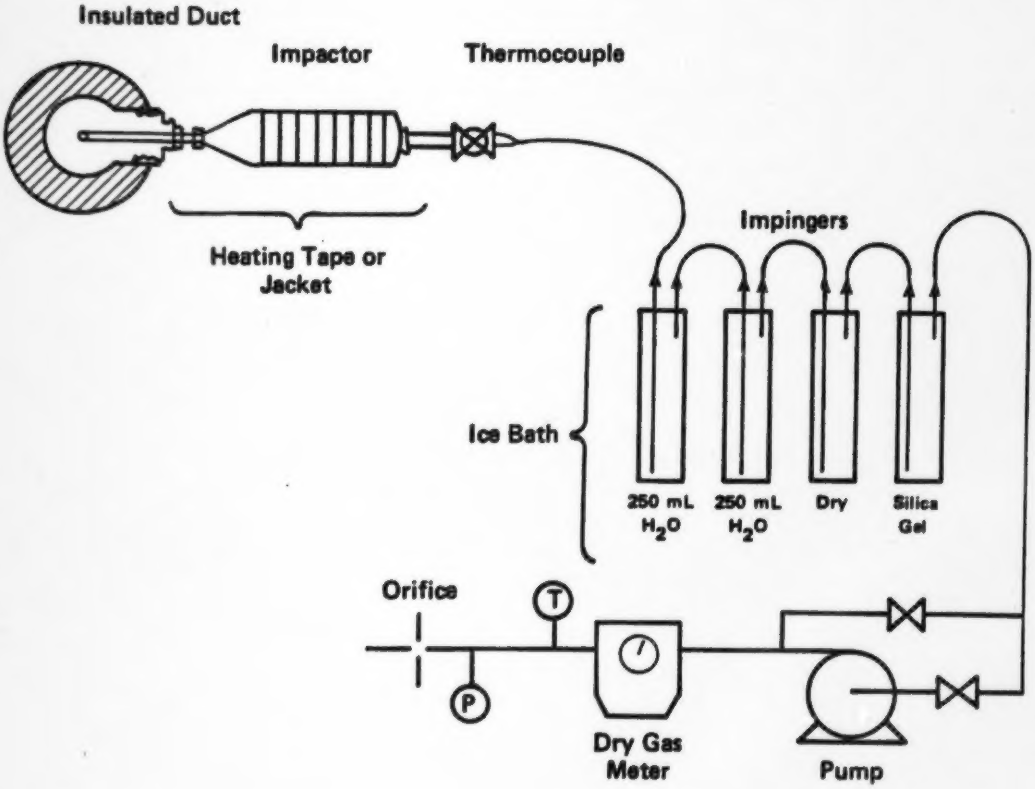
2. Compute the isokinetic sampling velocity for the duct of interest.

   a. The inlet with particulate concentrations of about 2 g/m^3 will require a smaller nozzle (~0.4 cm) and low sampling rates [roughly 0.01 m^3/min (0.4 scfm)]. A 0.170-in nozzle prepared from a 0.25-in tube is suitable. Also, short sampling times of a few minutes will be required. In some cases part of the last stage holes should be blocked to obtain the desired cutoff.

   b. The outlet of the control device will normally require a larger nozzle and higher flow rates to obtain acceptable quantities of material on the stages. Typically, flow rates of 0.05 to 1.2 m^3/s (0.5 to 0.7 acfm) should be used. The ETS Method 5 nozzles (0.232 in) are suitable for the outlet.

3. The impactor train should be assembled as shown in Figure B-2. Use Teflon tape to assemble the impactor and all fittings.

4. Fill in the data sheet. Note that for short runs (less than 10 min or so), it is useful to precalculate the dry gas meter



Insulated Duct
Impactor
Thermocouple
Heating Tape or Jacket
Impingers
Ice Bath
250 mL H_2O
250 mL H_2O
Dry
Silica Gel
Orifice
T
P
Dry Gas Meter
Pump

Figure B-2. Impactor train.

readings expected every minute of the test to allow close control of the sampling run.

5. The whole impactor train must be leak tested before and after the test. This is accomplished by plugging the inlet with Teflon tape or duct tape and turning on the train and carefully adjusting the valves to greater than 25.2 cm (10 in) Hg vacuum. An acceptable leak rate is less than 0.00057 am^3/min (0.02 acfm). The pretest leak check should be done both before and after preheating. After the leak check, the flow valve should be preset. Care should be taken to avoid sucking impinger solutions back through the train. Release the vacuum from the nozzle first, then shut off the pump.

6. The impactor should be preheated until the thermocouple on the impactor is up to stack temperature and held at that temperature for 10 minutes. The valve on the impactor probe should be closed while preheating.

7. The run is started by inserting the nozzle into the duct, adjusting position to the center line, then opening the probe valve and setting the desired flow rate. Normally the impactors are operated at one point in the duct.

8. During the run, record the test train parameters in systematic time intervals. (For example, in a 1-hour run, recordings should be made every 10 minutes.)

9. End the test by shutting off the pump and probe valve. Carefully remove the impactor from the port. Perform a posttest leak check.

10. Remove the hose and drain into the impinger. After the probe has cooled somewhat, remove the impactor and transport to the disassembly area.

B.5 LABORATORY PROCEDURES FOR MRI IMPACTORS AND PE AUTOBALANCE

B.5.1 General Notes

1. The balance power should remain on at all times. When not in use the balance stirrups should be empty and the weighing chamber door closed.

2. Be gentle with the balance stirrups. They are delicate!

3. To avoid grease and dirt contamination, handle the balance tare weights and calibration weights with the separate tweezers found in the tare weight box.

4. Handle the substrates carefully with other tweezers; avoid touching the greased surfaces.

B.5.2 Daily Setup of Balance

1. Set FILTER on HI.
2. Set RANGE on 200.
3. Zero display using COARSE and FINE zero knobs.

B.5.3 Daily Calibration of Balance

1. Place the 100-mg calibration weight on left stirrup.
2. When display stabilizes, adjust FINE CALIBRATION knob on back of control unit until display reads +100.00.

B.5.4 Loading Impactors

1. Be sure jet plates and substrates are in correct order.
2. Be sure all O-rings are in place.
3. Check the operating instructions and attach the correct probes to the impactors.
4. Inspect probe tips and repair or replace if necessary.

B.5.5 Unloading Impactors

1. Brush any loose particulate onto the next substrate below where the particulate is found.
2. Be careful not to lose portions of the filter when removing it.
3. Rinse out each probe with a few milliliters of acetone and drain the acetone into the appropriate cup. Air dry before placing cup into desiccator.
4. After rinsing, run a brush through each probe to dislodge any remaining material.
5. Check the condition of the desiccant in the desiccator and replace if necessary before storing substrates.

B.5.6 Sample Weighing (After Overnight Desiccation)

1. Record the date of the weighing in the weighing book.
2. Remove the substrates from the desiccator one at a time and replace the cover of the desiccator.

3. To weigh substrates and probe cups:

   a. Place the 500-mg and 200-mg tare weights on the right stirrup.

   b. Place the sample on the left stirrup and close the chamber door.

   c. When display stabilizes, record the number and sign.

4. To weigh filters:

   a. Place the 100-mg tare weight on the right stirrup.

   b. Place the filter on the left stirrup and close the chamber door.

   c. When display stabilizes, record the number and sign.

5. Record any comments of interest next to the weights in the book.

B.6 IMPACTOR SUBSTRATE PREPARATION

1. Prepare a grease-toluene mixture to be spread on the substrate. For temperatures of 149° C (300° F) or above, use Apiezon H; otherwise Apiezon L may be used. When using Apiezon H, a 5-percent (by weight) solution of grease in toluene solution is appropriate. For Apiezon L, use 10-percent to 20-percent (by weight) grease in toluene.

2. Be sure that the impactor substrates are clean and dry. Place 25 to 30 substrates on an oven rack using tweezers (do not use your fingers). With an eyedropper, put 5 or 6 drops on a substrate and spread the drops with a small paint brush to make an even coating. Do the substrates one at a time because the toluene in the solution evaporates quickly.

3. Bake the substrates at the temperature at which the impactor will be operated for at least 4 hours.

4. Desiccate the substrates for 12 to 24 hours.

5. Weigh the substrates and assign them to labeled petri dishes. Record the weight and petri dish number.

B.7 QUALITY CONTROL PLAN

B.7.1 Substrate Weighing

1. The balance will be set up as described in the procedure.

2. The amount of zero and span drift will be recorded.

3. The balance will be checked with the reference substrate and the weight recorded. If the weight does not repeat within 0.03 mg, something is wrong with the balance.

B.7.2 Filters

1. To prevent spurious filter weight determinations, the glass fiber filters are to be conditioned in the flue gas at stack temperature for 2 to 4 hours.

2. The filters are placed in an insulated thimble holder shell that has been fitted with a prefilter and the prefilter with a nozzle. Outlet stack gas is drawn through the thimble holder at 0.0057 to 0.01133 am^3/min (0.2 to 0.4 acfm).

3. After preconditioning, the filters are immediately placed in the desiccator.

B.7.3 Blanks

1. An impactor blank is to be run every 10 to 20 runs. At least one blank must be run as part of any test series.

2. The blank run is identical to the other impactor tests except that the flue gas is filtered to remove particulate before the gas reaches the impactor.